MACHINERY

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CHAPTERS IN THE EARLY HISTORY OF MACHINE TOOLS*—1

JOSEPH HORNER†

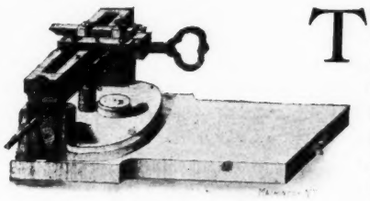


Fig. 1. French Lathe Slide-rest, 1772

THE first machine tools were the drills and the lathes, the first named being the descendants of the ancient fire drills of the archaeologists, and the second derived from the reciprocating cord-driven lathes. The drill dates from neolithic times, and the crude lathe in the form of the potter's wheel is as old, but the origin of the horizontal lathe is unknown, though its home appears to have been in Asia. The drill and the lathe were merely hand operated tools until the latter part of the eighteenth century, at which period two events occurred that were fraught with immense results. One was the placing of the steam engine on a practical basis by James Watt, the second the development of the slide-rest by Henry Maudslay. The first supplied a source of power, and the second embodied the mechanical guide principle in place of that of the human hand, which being rendered self-acting, and operated by power, has become the most essential element in all the later machine tools besides the lathes in which it had its origin.

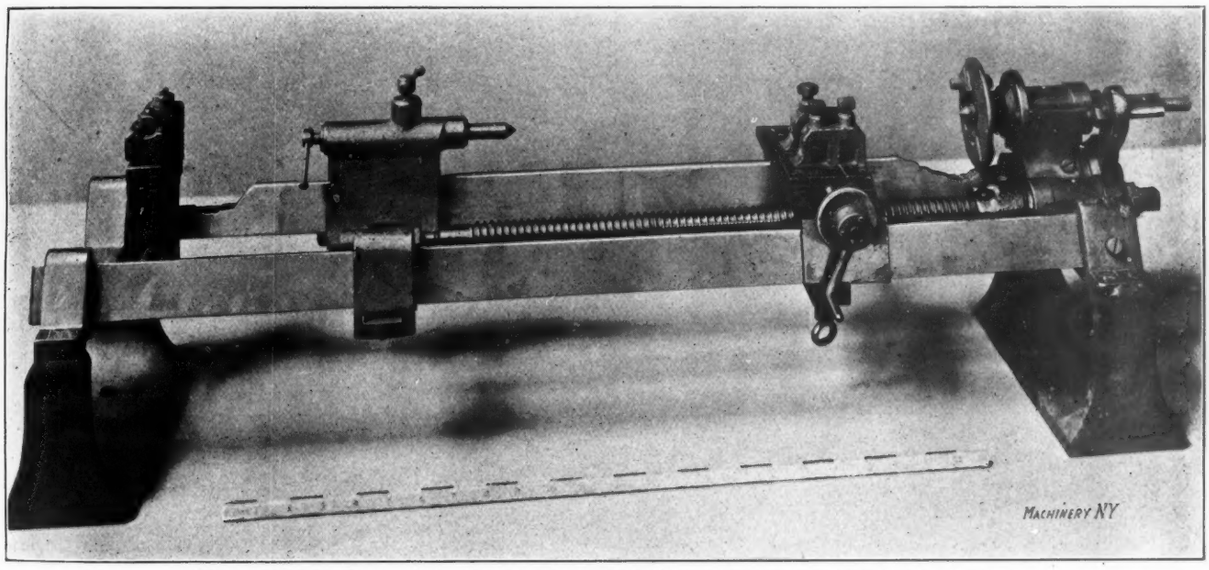


Fig. 2. Maudslay Screw-cutting Lathe, Latter Part of Eighteenth Century, South Kensington Museum

Before the invention of the planing machine, the lathe was the only engineer's machine tool in existence, unless we except rude drill presses, and trip and helve hammers. All machine operations performed then were of necessity done in the lathe, just as they might have been done to-day but for the subsequent invention of the machines derived from the lathe and planing machine. The lathe has been the parent of the boring mill, of the bolt cutter, and of dozens of special lathes large and small. From the planing machine have been developed the slotter and the shaper, and reciprocating tool arms in their numerous forms, so that the lathe, the drill and the planer are the cardinal types of modern machine tools.

Somewhat over 100 years ago (1794) there was but one English slide-rest in existence. It was in Joseph Bramah's shop, and was invented by Henry Maudslay. That plain tool carriage, "Maudslay's go-cart," has influenced the world's history far more than the great French revolution, then in its most terrible throes. That slide-rest was like no other made before or since, and it could only have been suitable for the very shortest, lightest pieces of work. It formed a part of the back poppet, on the base of which it was mounted. A frame carried a long tool bar, sliding horizontally in ways at the front of the poppet mandrel, operated by a long screw and handle, and of course overhanging a good deal to reach the work. It was provided with cross traverse, and a swivel base. But it marked an advance over the hand work, and was a link in the history of progress, though inferior to the French slide-rests of 1772 and earlier, with which apparently neither Maudslay nor Bramah were acquainted. Maudslay commenced business in 1797 on his own account, and made a slide-rest for his own shop which was in use at the beginning of the nineteenth century. He separated the rest from the poppet, retaining the three movements, but clamping the base to the triangular bar bed. One of the first great works in which its utility was demonstrated was in the manufacture of Brunel's block making machinery, begun in 1808. His works at Lambeth became a training school for engineers, and it is significant that some of the greatest mechanicians of the first half of the nineteenth century received their training there under Maudslay. In that school, and under such a master, Nasmyth, Whitworth, Roberts, and Muir learned their craft, and these with others improved and extended the applications of the sliding tool holder. Previous to the application by these men of the slide-rest principle to other classes of machines, nearly all work that is now done in these machines was performed either in the lathe or by hand.

But the mechanical guide, though invented and developed by Maudslay, had been in use by French opticians more than a hundred years previously, and slide-rests had been illustrated in French works. Very curious they appear to us now. In the tenth volume of plates of the French Encyclopedia (1772) several slide-rests are shown. In these, as in Maudslay's, the saddle was clamped upon the lathe bed. The tool could be operated within the limit of range of the slide only,

* For previous articles on early machine shops and development of machine tools, see "Chronology of the Nineteenth Century," December, 1900; "Early Machine Shops and Mechanics," October, 1902; "Talk on Lathe Spindles," by F. Emerson, May, 1904.

† Address: 45 Sydney Building, Bath, England.

and also, to a limited extent, for surfacing. Provision was made for elevating the tool point, by means of a screw, which on being turned, lifted the horizontal slide which carried the tool holder. It was capable of a swiveling movement. The construction was much simpler than that of Maudslay's. The bed or saddle, being flat, was bolted to the lathe. The swiveling plate was clamped to this by means of a single screw. The plate carried two uprights or horns recessed to receive legs from the horizontal slide. The slide carried the tool holder. The swiveling plate carried the elevating screw, and the horizontal slide the traversing screw, and the tool holder was moved by the surfacing screw. This must have been an unsteady structure. One of these slide-rests is shown in Fig. 1. The broad base has a T-groove, seen in the end, to receive the bolt which holds it to the bed. Upon this base a swiveling plate is mounted, which has two grooved horns on which the slide is carried by its horns, thus making of it an elevating rest. It is raised and lowered by a screw which has tommy-holes by which it is turned. Screws are provided for locking the slide after adjustment. The tool rest is traversed along the slide by a plain block fitting therein, by means of the screw and handle shown. The cross feed screw, which fits in a nut at the front of the slide, is capable of drawing the tool slide backwards as well as forwards.

Maudslay made a lathe previous to 1800 which was wholly self-acting for screw cutting and sliding, Fig. 2, now in South Kensington Museum. He put the change wheels at the rear of the headstock (not mounted in the illustration), and thence traversed the slide-rest through the medium of a lead-screw and split clasp nut on the under side of the saddle, the screw being carried down the center of the bed. The screw could be used also for sliding. The bed, instead of being a single bar of triangular section, comprised two such bars, secured at their ends in brackets bolted to standards. The headstock and poppet fitted on one bar only, but the slide-rest spanned both of them. The slide-rest was of gun-metal, the remainder of iron.

Another lathe of the same date, about 1800, also at South Kensington, was of a special character for cutting the fine threads for optical work. It may be mentioned that much of Maudslay's work was done in collaboration with the leading optical instrument makers of the time, who anticipated the engineers in screw cutting and gear cutting. The lathe bed, Fig. 3, is made of three bars, two of which carry the headstock and poppet, while the carriage of the rest is supported on all three. The screw to be cut is carried between centers, as seen. The lead-screw is just visible, being situated low down in the bed, and the sliding carriage is connected with it by a split nut adjustable from below. A stay at the back of the carriage steadies the work. A handwheel at the front has its edge graduated for the exact adjustment of the depth of cut. The lead-screw has 30 threads to the inch. It carries a wheel of 24 teeth which gears through an intermediate with one of 45 teeth on the lathe axis. Twenty-eight change gears are provided, ranging from 15 to 50 teeth. The intermediate wheel, as seen, has a wide face and is carried on a swinging adjustable arm to connect gears of various diameters with those on the fixed centers. A collection of threading tools is seen in a tray in front of the lathe, both single pointed ones and chasers being represented. Some samples of screws are seen in the rack in front. There is also a wide jawed caliper, looking like pincers, for measuring the diameters of screws. The long legs of the calipers are proportioned to increase the reading in the proportion of four to one.

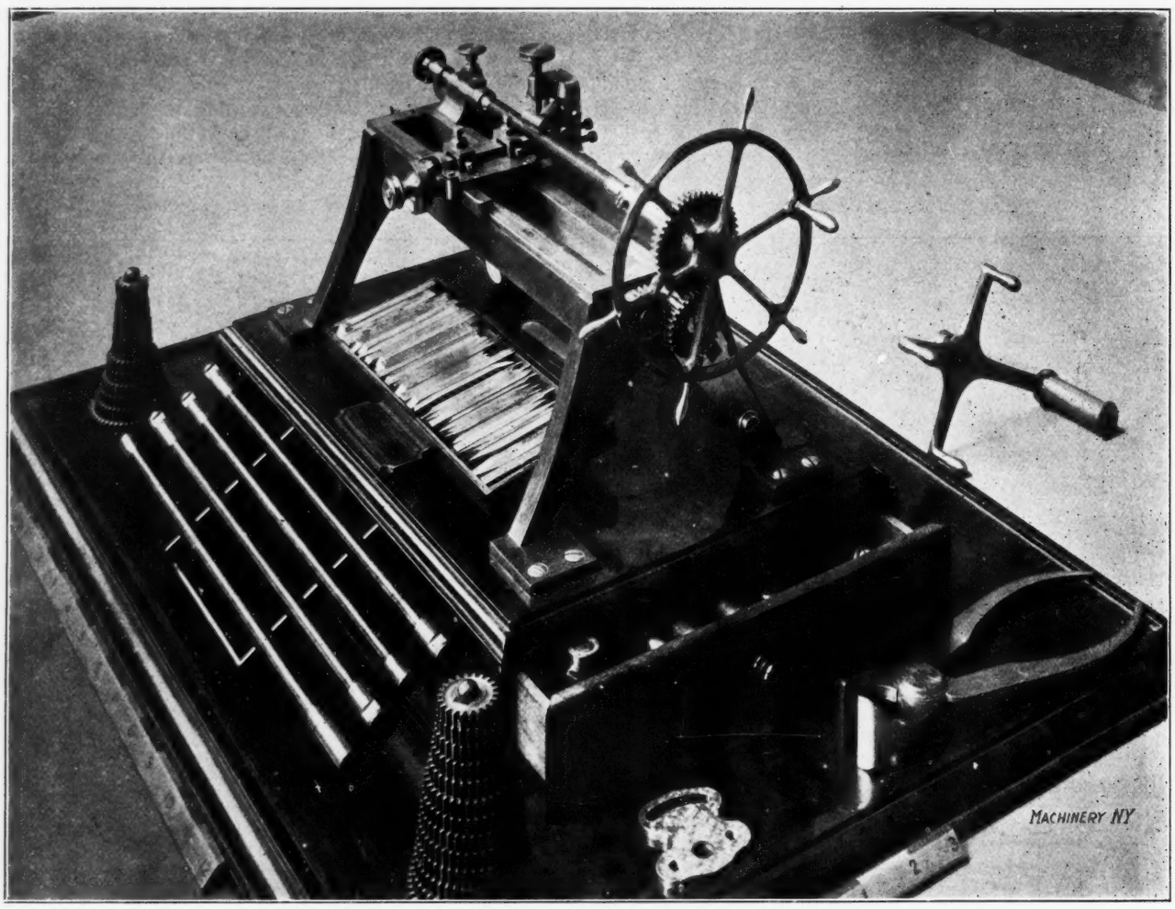


Fig 3. Maudslay Screw-cutting Lathe, about 1800, South Kensington Museum

Later, Maudslay made lathes for other firms, which save for their rather skeleton-like appearance were much like many which have been in operation until within the present generation—beds with flat ways, the hand slide-rest with three movements, the hand T-rests, the boring plate steady, and the back gear. The latter was not like that at present used, but was driven independently from a three-stepped cone on the back gear spindle, this being independent of the stepped cones on the mandrel. The back gear was put into engagement by a sliding pinion which then engaged with a wheel on the mandrel cones. It was therefore a single back gear only. There were several developments in back gears before they assumed the present form.

Nasmyth has illustrated an early method of screw cutting in the lathe, in which change wheels were placed, one on the work, the other on the end of the longitudinal feed screw of the slide-rest.

The earliest lathes were of dead center type, a principle which survives in watchmaker's turns, axle turning lathes, and in cylindrical grinding machines. The rotation of the work was at first effected by a cord, which survived in the fiddle drill, followed by a spring pole and cord operated from a treadle. The bow can be traced in works published in 1568-1569. Moxon shows it in 1703, and Bergeron in 1792. It is also illustrated in the French Encyclopedia under date 1772. The movement was necessarily one of reciprocation. But the wheel driven lathe was also in existence, and illustrated in 1624, 1677, 1701; and in the French Encyclopedia, combination lathes were in use, employihg either bow or wheel.

The development of the running mandrel was slow. The first occurs in 1568. The earliest were of wood, followed by those of iron running in wooden collars, whence the traversing mandrel for cutting screws was developed, with divided bearings of lead or tin cast in dovetailed recesses in the head. The crude lathe heads passed through many stages of development, as did also the loose poppets. The beds, originally of wood, their faces protected later with iron plates, came to be made as triangular bars of wrought iron, or as separate bearers of cast iron. To this period, about the beginning of the nineteenth century, is traceable the veed edges which survive to-day. Afterwards these were cast together with ends. The writer well remembers as an apprentice some old lathes of this kind still at work, driven with ropes on veed pulleys, though of 8-inch or 10-inch centers, and old men of between 70 and 80 operating them, often using heel tools, though slide-rests were fitted.

The modern machine shop owes its existence to the development of the steam engine by Watt. The second Soho Foundry, started in 1795, was probably the first shop in which machine tools other than the lathe were constructed, and employed on an extensive scale. Many of these tools were recently still in existence, venerable relics, more than a century old. At that early period a notable feature was the massiveness of the machines which were designed and constructed, necessarily capable of dealing with the large pumping and marine engines of the later years of the eighteenth century and the early years of the nineteenth century. One of the old double geared face lathes at Soho would take a diameter of 26 feet and a width of 12 feet from the faceplate. It had back gears, the driving taking place on an internal spur ring bolted to the back of the faceplate. It had also five slide-rests, rendered self-acting by means of chain and ratchet feed actuated from the mandrel through an overhead. Some of the old lathes at Soho were like the modern break lathes, having a transverse bed on longitudinal bases.

A heavy faceplate at Soho was driven by worm gear, double threaded, the wheel being a mortise with cogs of 2 inches pitch and 6 inches length of face. The worm was driven by a four-stepped cone. A pit in front of the faceplate took large work, and a massive slide rest opposite it was power-

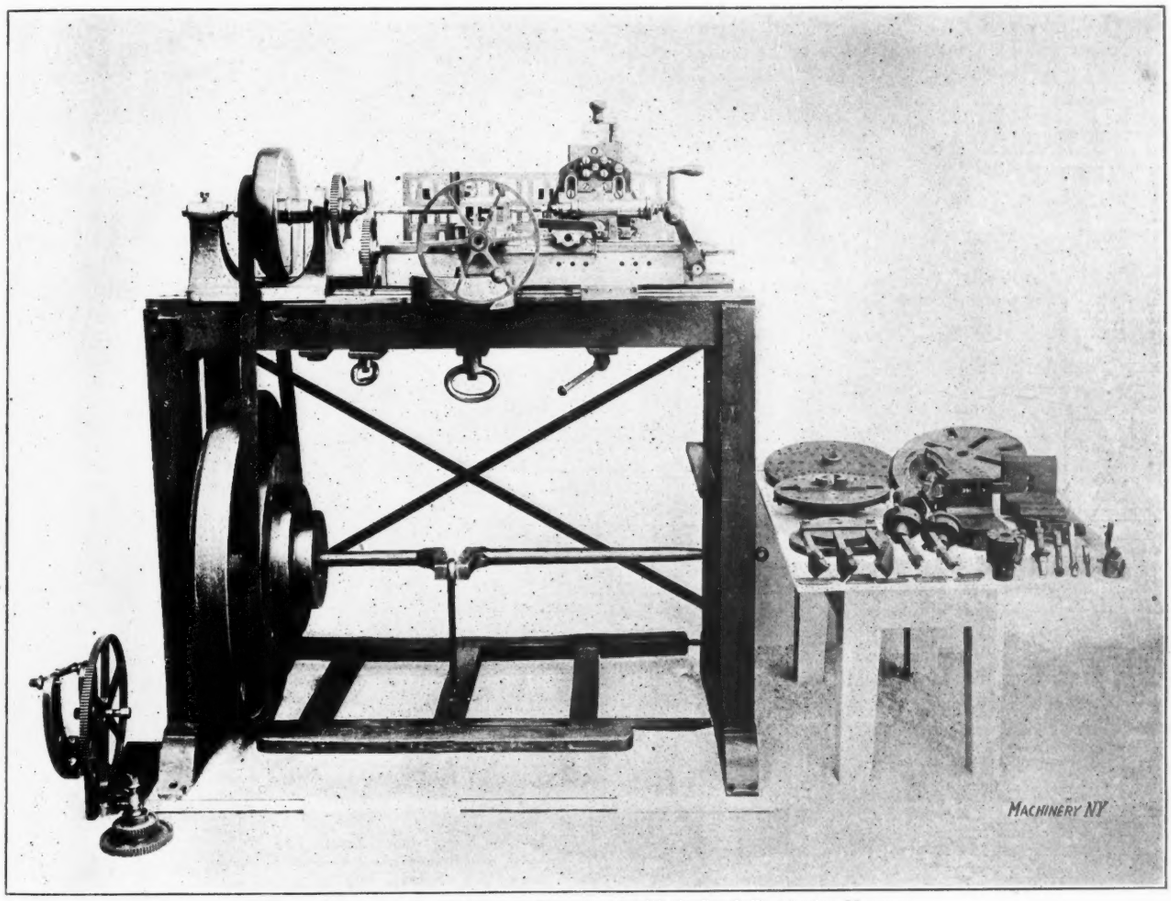


Fig. 4. Lathe used by Babbage in Experimental Work, South Kensington Museum

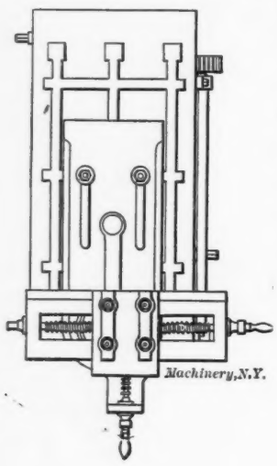
driven from a shaft overhead, belted from the lathe mandrel. At that time square threaded screws were cut with chisel and file by hand, and specimens of these, 2 inches diameter and 10 feet long, were recently in existence.

A very large face lathe constructed by Henry Maudslay was until a few years ago in existence at the Lambeth works, now dismantled. It was capable of facing up to 40 feet diameter, and had been used to turn the rims of flywheels. It had been employed also as a boring lathe by the substitution of a boring bar, and had bored cylinders up to 10 feet in diameter. The mandrel was 9½ inches diameter in the larger bearing.

An interesting old lathe in the South Kensington Museum is shown in Fig. 4—interesting for three reasons; it was the one on which Babbage performed his experimental work, it contains the second compound slide-rest made by Clement, and it is an example of a machine tool in which all operations were performed that could be performed, in accordance with the practice of that period.

The bed is of cast iron carried on wooden supports. A

single pulley is driven from a three-stepped driving wheel, and the headstock was shifted along when the pulley had to be brought into line with either step. A division plate on the pulley has circles of holes of 200, 180, 112, and 12 holes each. The slide-rest has three slides, the lowest being shallow to be clamped in any position transversely to the bed. On this is bolted a long slide with a lead-screw of nine threads to the inch, the threads being of vee section, and the slide being capable of rotary adjustment through an angle of about 45 degrees. The screw operates the uppermost slide which has alternative positions for the tool holder. Babbage, it will be remembered, designed the first tool holder, which was a model not essentially different from several that are in use now. One of these is seen lying on the slide-rest. The slotted bracket seen behind the rest, and which is fixed on the lowest slide, is used for the attachment of work which has to be planed, shaped,



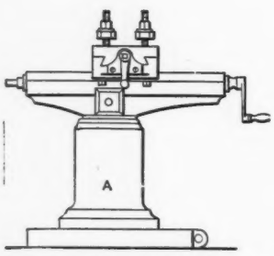
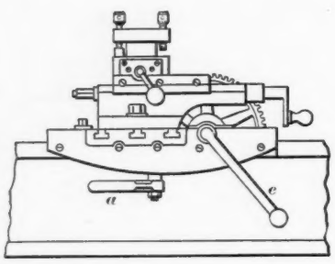
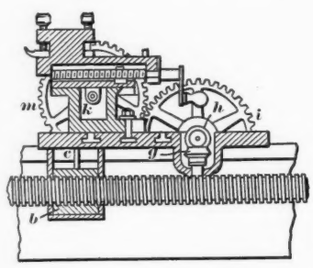


Fig. 5. Slide-rest of Boring and Turning Machine

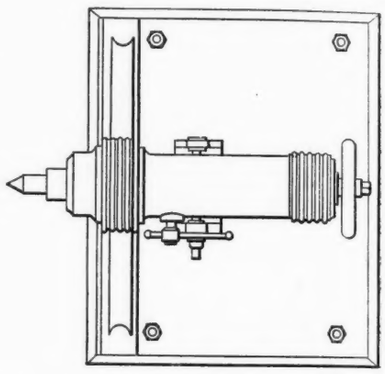
or slotted. The lathe is also rigged up for screw cutting. A chuck with the first change wheel is put on the mandrel, and a suitable train of gears, held by a quadrant bolted to the lathe bed, terminates in a wheel keyed on the end of the lead-screw of the slide-rest. Several appliances were added between 1824 to 1830, including various faceplates and chucks.

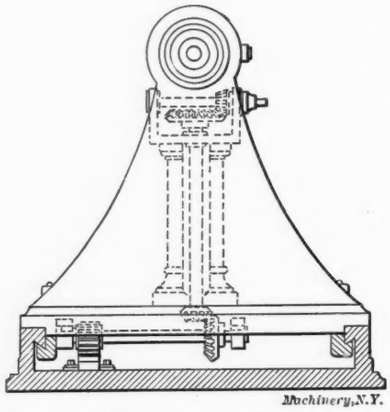




A two-jaw self-centering chuck is one of these, centered by means of a right- and left-hand screw. There is an adjustable face milling cutter, a large facing cutter, and a machine vise. Wood turning tools are points, gripped in holders by means of a strap, seen on the table to the right.

Many of the slide-rests in use sixty or seventy years ago, Fig. 5, were evidently variations or modifications of the older tee rests employed for hand turning; that is the sliding arrangement involved the use of a socketed pillar *A* such as was used for the tee rests. The two slides for longitudinal and cross traverse were mounted upon and screwed in the pillar, and being removable, the tee rest could be substituted for hand turning. To effect an extent of movement such as would be required for setting the tool to suit work having wide ranges in diameter beyond the capacity of the comparatively short traverse slide, the socket was carried on a sole plate movable across the saddle, to which it could be tightened with bolts. With the disuse of hand turning, the socket has been discarded in favor of the more substantial and more accurate arrangement which is embodied in the modern lathes. The tool "post" survived long as a post, because it was so conveniently used alternatively for receiving a tee rest for hand turning, and a slide-rest. It can be traced from the French Encyclopedia, 1772, down to the period of the writer's apprenticeship. In a





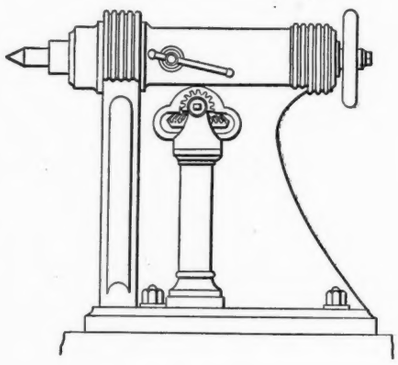


Fig. 6. Poppets of Boring and Turning Mill, Kinmonds, Hutton & Steel, Dundee, Scotland. About 1847

rather disguised form the same design exists in the present wheel lathes in which the post is fixed and the sliding given through a ratchet feed.

The slide-rest in its present essential design was due to Whitworth. An early form is illustrated in Fig. 7. There is no provision as yet for angular turning, and no separation

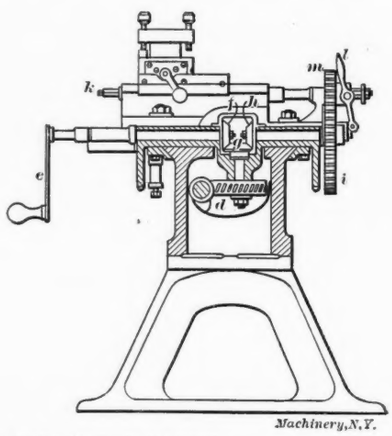


Fig. 7. Early Whitworth Slide-rest

between the feed rack and lead-screw. But in other respects it resembles, in the main, present-day rests.

The design shows the carriage with guide strips embracing a bed with veed edges, the carriage being clamped with the handle *a*. The guide screw lies within the bed, and is placed to one side for protection. The body of the rest is fitted and clamped with tee head bolts to the carriage. It supports the transverse slide, which is actuated by a hand-

screw, or by power, and this again receives the tool holder similarly actuated. The details of these are obvious without special references. The curious part of this design is the method of utilizing the lead-screw for screw cutting through the nut *b*, which is disengaged by the pin *c*; and for feeding through the tangent wheel *d*. When the clasp nut is out, and the lead-screw not being rotated, the threads of the screw are made to fulfill the function of rack teeth. This is done by turning the handle *e* which drives the bevel wheels *f* and *g*, the latter being on the spindle which carries the tangent wheel *d*.

The cross feed is derived from the same bevel wheels, being transmitted through *h* to the wheel *i*, which is always running when the rack feed is in. The cross-feed screw *k* is put into action by the lever *l* and wheel *m*.

Fox of Derby was using a rack and pinion for traversing the slide-rest about 1830.

The early loose poppet which had the mandrel screwed along its length and was turned in a block of wood, or a metal nut, was superseded by the plain cylindrical mandrel as we know it to-day, the invention of Joseph Clement, and it is said simultaneously by M. Collas, a Frenchman. The transverse adjustment of the headstock for taper turning is old, being certainly in use before 1847.

As lathes increased in weight, provision had to be made for effecting the movements of the loose poppet by power. The present simple device of a rack and pinion in front of the bed or at front and back, was not so obvious as it seems now. In a drawing of an old heavy lathe (1847), Fig. 6, by a defunct Dundee firm, a roundabout way was adopted. A rack ran along within the bed, having its teeth uppermost. A vertical shaft within the poppet turned by a pair of bevels and winch handle at the top actuated another pair of bevels in the base, the last of which on a transverse shaft carried a spur pinion which engaged with the rack.

Long after the adoption of metal mandrels and metal collars or bearings these were divided longitudinally. Whitworth designed the conical form of solid bearing, with the front cone much steeper than the rear one, which has remained standard Manchester practice for all except the heaviest lathes.

This outline brings the subject of the lathe down to living memory. In the next article it is proposed to outline the history of some of the other machine tools.

* * *

A project is on foot for building an international dam across the Niagara River to maintain the water level of Lake Erie at not less than a certain minimum height, the year round. Every Autumn the level falls so as to seriously interfere with shipping, and it is for improving the present condition that the dam is considered. If built, the dam could be used for another purpose equally laudable and valuable. There has been much agitation against the defacement of the natural beauty of Niagara Falls because of the amount of water used by the power companies which materially reduces the volume of flow over the falls in low water periods. The dam could be used to impound water at night, practically cutting off all flow for certain hours through the night and storing it up for use in the daylight hours. In this way it would be possible for the power development of Niagara Falls to be materially increased for daylight service without decreasing the normal volume of flow, the daylight flow being sufficiently in excess of the normal flow to compensate for that used by the power concerns.

* * *

Cheaper radium is promised by the discovery that the ash of lignite found in Sweden contains radium which can be extracted by an inexpensive process devised by Dr. Gustaf Hellsing. A company has been formed for exploiting the invention. According to *Engineering* it is expected to extract about 0.075 grain troy from each ton of the raw material. The technical side of the problem is fully solved and there is no doubt as to where and how the radium can be obtained, but there is, of course, the risk that the present enormously high price of radium may be reduced through fresh discoveries.

OBSERVATIONS ON THE MAKING OF HIGH-SPEED STEEL TOOLS

O. M. BECKER*

The collection and orderly preservation of data as a basis for subsequent rational deduction and intelligent procedure has long been considered an essential concomitant of the scientific method; and it is now coming to be pretty generally understood that the scientific method is also the successful business method, whether the end sought be the perfection of technical processes or the organization of a business system. The preservation of appropriate data as a guide to the production of superior high-speed steel tools by the simplest efficient methods, should, therefore, need no arguing. The sneer of the small man in a small place at "red tape" and "over-refinement" is not heard nearly so much as formerly; and this is as it should be, especially as regards the manipulation of the new steels. The question under consideration concerns not alone the keeping of data, but, more particularly, the kind of data to be kept.

TOOL RECORD

Tool Name.....Size .....No.....Lot No.....
For Piece No.....Operation No.....Department .....

Steel .....Analysis: C...T...Cr...Mo...
Critical Point ..... S...Si...V... ....
C. P. Determined.....Analysis Determined .....

Forging Temperature.....Forge No.....Smith.....
Hardening Temperature.....Furnace No.....Operator.....
Tempering Temperature.....Furnace No.....Operator.....
Ground before Hardening?....Finish Grinding by.....
Date Finished.....Checked by .....

Memoranda .....
.....
.....
.....
.....
(Signed)

Kind of Data to Preserve

Within moderately well established limits the precise treatment best calculated to develop the highest efficiency in a tool intended for a special purpose is usually found by the "cut-and-try" method. It is desirable, therefore, that besides the record of the performance of the tool, there should be data showing the precise conditions under which the tool was treated while in process of manufacture. These conditions are comprehended in the tool record shown herewith;

DIRECTIONS TO TOOL-MAKERS

1. Lot No.....
2. Kind of Tools.....
3. Steel to be Used.....
4. Class of Work on which Used.....

5. Hardening Furnace .....
6. Temperature .....
7. Method of Cooling.....
.....
8. Temperature of Bath.....

9. Method of Tempering.....
10. Tempering Furnace .....
11. Temperature .....

12. Memoranda .....
.....
.....

Completed ....
(Signed)

once definitely known, they can be varied from time to time as may be indicated by the results obtained from the tool at work. Obviously, when a set of conditions is found which yields just the proper excellence, it is necessary only to duplicate these conditions to obtain satisfactory results. The proper conditions will then be definitely indicated in the directions accompanying each subsequent lot of tools of the kind. It will be understood, of course, that there is small value in such data and directions unless the tool manufacturing plant is equipped so as to take advantage of this information; that is, unless the plant has a variety of fur-

* Address: Berwyn, Ill.

naces and other apparatus suitable for obtaining accurate information as to conditions, and for meeting the requirements indicated upon the direction cards. Time spent in experimenting intelligently—that is, experimenting with adequate appliances, materials and data—to fit the tool most nearly to its work, and to give it treatment which will produce the highest attainable efficiency in its special work, is well and profitably spent.

Hardness or Temper of High-speed Steel Tools

Of the elements involved in tool efficiency, hardness or temper formerly was considered the most important, the design and conditions of use being little regarded. At the present time, the intelligent making of high-speed tools involves a consideration of all these and other elements, relegating to hardness or temper its appropriate place. The extreme hardness of many of these tools has frequently led to the inference that a tool has been properly treated if it is very hard, so hard that a good file will not "touch" it. However, extreme hardness is not always an indication of the efficiency of a high-speed tool; although it is necessary in certain classes of work (cutting refractory stock, for instance), in others it not only is unnecessary, but perhaps even undesirable. As a matter of fact the largest users of the best makes of high-speed steel find that for many purposes tools do the best work and give the most efficient service when soft enough to be "touched" by a good file, and even when so soft that it will "take hold." However that may be, the file test for high-speed tools is quite valueless even in those cases where it is desirable that the degree of hardness be determined. Such tests, to be of value, would require that the files must be absolutely uniform in temper. Even the best of files, however, vary more or less in temper and hardness; and a tool passed as "hard enough," when tested by one file might easily fail to pass the test when tried by another, presumably of the same temper.

Fig. 1 Planer Roughing Tool with Machine Steel Shank and High-speed Steel Cutting Edge composed of a Comparatively Thin Piece of High-speed Steel brazed to the Shank. Used in the Shops of the Lodge & Shipley Machine Tool Company, Cincinnati, Ohio

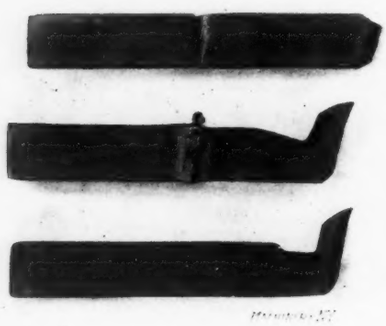


Fig. 2. Diamond-point Lathe Tool made with High-speed Steel Cutting End electrically welded to a Mild Steel Shank. Courtesy of the Thompson Electric Welding Co.

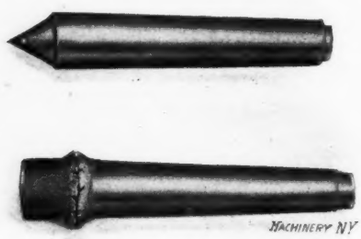


Fig. 3. Lathe Center made with High-speed Steel Point electrically welded

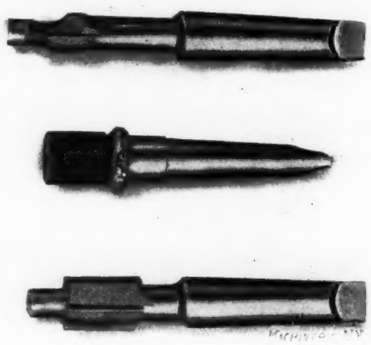


Fig. 4. Broken Counterbore Repaired by Electric Welding

Allowances to be Made for Variations in Sizes of Tools After Hardening

Usually it is of no particular consequence, in tools of the lathe or planer type, whether the stock is exactly sized or not, so long as there is enough material to withstand the enormous strains and to prevent vibration, and consequently inferior and inaccurately sized work. In other types of tools, however, as in drills and mills, it is necessary, when ordering stock, to make allowance for the burnt skin which must be removed after hardening. While the effect on high-speed steel is apparently much less marked than in the case of the carbon steels, nevertheless the long-continued high heat in annealing affects the surface of the bars enough to make it necessary to remove the same to a depth varying more or less according to the size of the bar. In stock above an inch in thickness one-eighth inch should be added to the required size, and in large sizes, the proportionate allowance decreases rapidly.

The allowance for shrinkage of finely-sized tools during the hardening process is distinct from the allowance just mentioned. Loss in size is almost invariably the result of exposure to the air while the tool is very hot. The loss due to actual shrinkage is so small, except in large tools, as to be scarcely appreciable, and is usually negligible when the barium chloride process is used. If the hardening is done by the customary methods, a slight allowance is possibly desirable in certain cases, say in the arbor holes in milling cutters, the diameter of taps, etc. With care in hardening, even by the customary processes, the variation in a 1-inch diameter will scarcely exceed 0.0005 inch, and more likely will be less, though indeed it may be as great as 0.001 inch and even more—so much depends upon the care exercised and the method employed. It should scarcely need to be added that the holes in all mills intended for very accurate work should be ground after hardening, the mills having been first carefully centered in a chuck.

It might also be mentioned that apparent variations in the size of tools like threading dies and taps and other tools which cannot be ground after hardening, are frequently only the effects of the roughening of the surface during the treatment. The barium process very largely overcomes this difficulty and does so entirely, unless, as is generally the case, the defect is present before the hardening. This roughness usually arises from the method of cutting the threads, or teeth, as the case may be. Such threads or teeth are best, and of course most quickly, cut by milling, lubricating the cutter with thin oil. Next to this it is best to rough out the threads with a chaser, as close to size as may be, without lubricant, and then to re-cut or finish with a single-point tool held in a spring-thread holder, the threads being kept slightly lubricated with very thin oil. To compensate for the roughness often present in high-speed tools of this class, it is customary to give rather more relief than in the case of those made of ordinary steel. The increased relief minimizes the lodging of particles of steel in the surface of the cutter behind the cutting edge, which tend to act as cutters, sometimes very appreciably increasing the cut.

Extreme smoothness is also a desirable quality in high-speed drills, but it seems impossible to obtain by present methods of cutting a smoothness of surface like that of the carbon steel drills; to secure this it is necessary to polish the flutes. If the hardening is by the barium process, the polishing may be done before hardening, for that process leaves the surface absolutely unimpaired.

Disadvantages of High-speed Steel Tool-holders

The early method of economizing in steel by using tool-holder stock rather than making the entire tool of high-speed steel, in the case of those tools whose cutting edges or points work without intermission (as those used for turning, planing and similar operations) is open to criticism, and is not

now so generally followed as formerly. A characteristic of the operation of high-speed tools is the rapid generation of heat in the cutting edge. In the case of milling cutters and kindred tools this is of small consequence, because the cutters are intimately attached to a relatively large mass of metal which conducts the heat away very efficiently. Furthermore, these cutters work intermittently, each for a very brief space of time, and for the remainder of the revolution are exposed to the air and cooled by it. The cutting edges are not allowed, therefore, to get exceedingly hot, as is the case with the edge of a turning tool run at the same speed. It is necessary that the body of such a turning (or similar) tool be large enough to conduct away a considerable portion of the heat generated at the cutting edge; and in order to do this effectively the tool must be continuous; that is, there must be no appreciable separation between the part of the tool which does the cutting and the body from which most of the heat radiates, as there is ordinarily when a small piece of steel is held in a tool-holder. There are indeed tool-holders which minimize this difficulty; but even these are not satisfactory in large sizes.

Methods of Uniting High-speed Steel with the Tool Body*

From the first, methods were sought whereby high-speed steel cutting points could be intimately combined with tool bodies of ordinary and much cheaper steels. For the most part the methods tried were ineffective and impracticable. The reasons are not well understood. The disinclination of the two steels to unite probably is due to a difference in their coefficients of expansion. There is, however, no trouble in brazing them together; and when this does not involve placing a great strain upon the brazed joint, this method does very well. Obviously the cutters are hardened before being brazed into place. A successful example of such a combination is a lathe or a planer tool made with practically no forging and with a relatively thin plate of high-speed steel brazed to the front and top to form the cutting edge. Rose and other forms of reamers and mills have been made in a similar way, the body of machinery steel being machined with recesses for high-speed blades, which are brazed into place. Such tools have been in use for several years, with satisfaction. The latter, especially, are as good as if of solid high-speed steel except when it is essential that they be re-annealed or re-hardened—which is seldom necessary.

Almost as soon as the new steels made their appearance the writer suggested and demonstrated the possibility and feasibility of welding, electrically and autogenously, a high-speed cutting point and a machinery steel tool body, the latter of such proportions, of course, as to give the requisite strength to the tool. Such tools conform to the requirement of being perfectly continuous, and the weld is practically as strong as the rest of the tool. It is feasible to forge the end to any required shape as if the entire tool were of high-speed steel; and, since in hardening only the nose is heated to a high heat, the machinery or tool steel body is in nowise impaired. The method of electrical welding, as used in this connection, is exceedingly simple. The two pieces to be welded are attached to the terminals of a circuit of suitable voltage, and the edges brought together. The resistance to the passage of the current offered by the imperfect contact sets up enough heat to melt the metal and forms a perfectly homogeneous junction. The autogenous (oxygen and acetylene blow-pipe) method is almost as simple; the flame is directed into the crevice where the two pieces are brought together, and melts the adjacent metal so as also to form a homogeneous joint.

Another method (patented) recently brought forward, somewhat resembling brazing, is asserted to give a joint fully as strong as the rest of the tool. A thin film of copper is placed along the line of the joint, and the parts to be welded are surrounded by a reducing compound and then placed in a furnace raised to a temperature of about 1,200 degrees C. (2,200 degrees F.). The copper flows freely into the interstices and is said to produce actual cohesion between the adjacent molecules, making a perfect joint, so strong that a fracture will follow a new break rather than pass through the joint.

* See MACHINERY, October, 1908, "Electric Welding of Tools."

These methods are available for all classes of tools made partly of high-speed and partly of machinery steel or other materials. Reamer and mill blades, die faces, shear blades, jack knives, etc., all are readily welded to supporting forms or backs and make tools quite as efficient as if of solid high-speed steel—and generally much more so than if the cutters or faces were attached by screws, bolts, rivets, or similar methods. Long-shank and extension drills, reamers, etc., can readily be made with the cutting parts of high-speed steel and the shanks of cheaper steel. The processes mentioned, especially the electrical, are available also for the repair of broken tools, many of which can thus be saved for further use. The repairing may involve the welding of the broken parts or the replacing of an old part by a new, as may be most expedient.

Cutting High-speed Steel

Only an expert can nick and break high-speed steel from the bar without damage to the structure adjacent to the fracture—and even an expert cannot be sure of doing so with safety; the best way, where the end is to be used for working purposes, is to cut the bar. The circular saw most frequently used does very well, though a band saw works better and rather more rapidly. Small bars can readily be cut in bundles, if held very rigidly. The saws, obviously, should, themselves, be of high-speed steel. Complaints have been made that it is impossible to saw these steels. The complaints probably originated in the use of improperly hardened saws; for there is no difficulty whatever in cutting them with suitable saws. A singular but most effective method has been employed to some extent. It consists in the use of a highly-speeded disk of tough steel. When an unused disk is first forced against the high-speed steel, the disk does not take hold well; but after being run in contact with the high-speed steel for a time it cuts perfectly and rapidly, leaving a clean burless kerf. The disk may be of any steel tough enough to withstand the tremendous centrifugal (and other) stresses set up by the pressure and the terrific speed required. Just why such a disk cuts is not exactly clear. The periphery is usually found studded with particles of the steel being cut, and the "sawdust" appears to be the result of true cutting.

Detecting Cracks in High-speed Steel Tools

Fine cracks in tools are most difficult to discover. Even the microscope often fails to disclose them. Generally they can be detected, if present, by the very simple expedient of moistening the suspected surface with petroleum, rubbing clean, and then wiping off with chalk. Some petroleum enters the cracks and afterwards sweats out, moistening the overlying chalk. The nature and extent of the cracks are thus rendered visible. This frequently is of great importance in testing lots of high-speed steel tools.

Re-forging of Worn-down Tools

Tools which have worn down so as to be useless can usually, when made of solid high-speed steel, be forged or machined down and worked into tools of smaller size, if ordinary care is exercised. It is necessary always to re-anneal prior to attempting to machine such old tools; and it is also expedient when forging them to smaller shapes. In passing, it might be mentioned that re-annealing is desirable after machining and before hardening all sorts of intricately-shaped tools, in order to relieve any possible machine-caused strains. In re-forging high-speed tools, whether for reduction in size or merely in re-fettling, it is desirable that they be heated rather slowly at first; they should not be thrust cold into a very hot fire.

* * *

An alloy of iron and thorium which possesses remarkable properties has been produced by Mr. Welsbach, the well-known inventor of the incandescent gas mantel. When struck lightly against a piece of iron this alloy emits exceedingly bright sparks, and sufficient heat is developed to ignite tinder instantaneously without the repeated efforts required with the old-fashioned flint and steel. The new thorium flint may be called an everlasting match, and will undoubtedly be very useful to explorers and tourists and for the ignition of explosives.

CALCULATION OF PILLAR CRANES*

CHARLES A. SCHRANZ†

The maximum stresses in the different parts of a pillar crane are due to the maximum load lifted (the live load) and the weight (dead load) of the crane parts themselves. Fig. 1 shows a conventional design of a hand pillar crane, and assuming, for an example, the maximum load $Q = 5$ tons, the height $H = 12\frac{1}{2}$ feet, and the radius $A = 13$ feet, the stresses in the different parts of the crane are calculated as shown in the following.

Stresses in the Boom

Fig. 1 shows plainly that the stresses in the boom and tie-bars are not due to the live load only, but that the weight

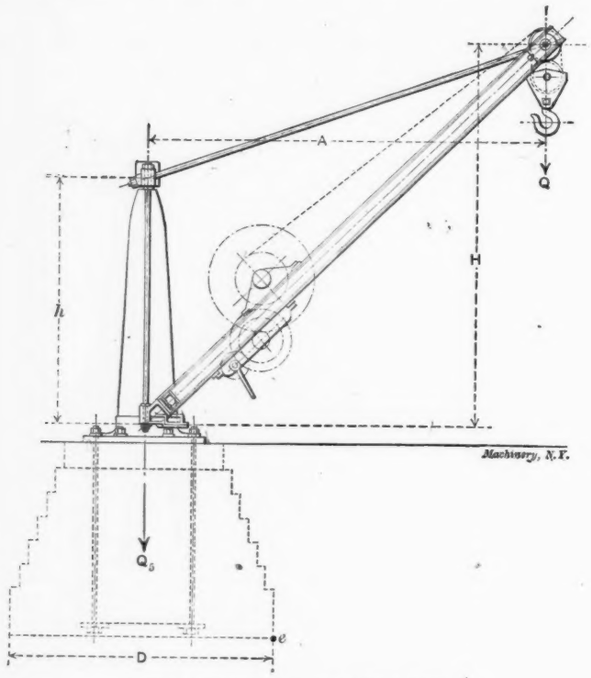


Fig. 1. General Layout of Pillar Crane

of the eccentric parts of the crane (*i. e.*, boom, tie-bars, hoist, sheave wheels, crane hook and hoisting rope) and the pull of the hoisting rope must also be considered. As it is not possible to determine the dead load accurately before the crane is calculated and designed, it must be assumed. A practical method is to assume the weight of the above mentioned eccentric parts of the crane as half of the maximum live load, and its center of gravity at a distance equal to one-fourth of the radius of the crane from the center line of the pillar. These assumptions expressed in formulas read:

$$Q_1 = \frac{Q}{2}; \text{ or } Q_1 = \frac{10{,}000}{2} = 5{,}000 \text{ pounds.} \quad (1)$$

$$a = \frac{A}{4}; \text{ or } a = \frac{13}{4} = 3\tfrac{1}{4} \text{ feet.} \quad (2)$$

in which Q_1 = the weight of the eccentric parts of the crane, and a = the distance of the center of gravity of Q_1 from the center of the crane. If the actual figures, determined after the crane is calculated, differ considerably from these assumptions, corrections have to be made.

The next step is to determine the height h of the pillar, a practical rule being to make h about 0.6 of the radius of the crane:

$$h = 0.6\,A; \text{ or } h = 0.6 \times 13 = 8 \text{ feet, approximately.} \quad (3)$$

The frame diagram shown in Fig. 2 can now be drawn. According to the law of equilibrium the sum of moments of the external forces must be equal to the sum of moments of the internal forces about the same center. The moment M_1 of the internal force in the boom is the product of its compressive stress C and its lever arm e (5¾ feet) about center K:

$$M_1 = Ce \quad (4)$$

The moments of the external forces about center K are:

$$\text{The moment of } Q = M = QA \quad (5)$$

$$\text{The moment of } Q_1 = M_1 = Q_1 a \quad (6)$$

$$\text{The moment of } Q_2 = M_2 = Q_2 b \quad (7)$$

Dimension b is found to be 4 feet by scaling.

Substituting the values:

$M = 10{,}000 \times 13 = 130{,}000$ foot-pounds,

$M_1 = 5{,}000 \times 3\frac{1}{4} = 16{,}250$ foot-pounds,

$M_2 = 5{,}000 \times 4 = 20{,}000$ foot-pounds.

The sum of above moments is:

$$M_s = M + M_1 + M_2 = 130{,}000 + 16{,}250 + 20{,}000 = 166{,}250 \text{ foot-pounds.} \quad (8)$$

As explained above

$$M_1 = M_s \quad (9)$$

or

$Ce = M_s$ and transposing

$$C = \frac{M_s}{e} = \text{the compressive stress in the boom.} \quad (10)$$

Substituting the values in above formula

$$C = \frac{166{,}250}{5\frac{3}{4}} = 28{,}910 \text{ pounds.}$$

The unsupported length of the boom scales about 17 feet, and as in this case it is made up of two channels the load on each channel is $\frac{C}{2}$ or 14,455 pounds The inclination of the two channels towards each other need not be taken into consideration as the increase of load is very small. Consulting any handbook of information relating to structural steel we find that a 6-inch × 8-pound channel has a section area of 2.38 square inches and a radius of gyration with respect to an axis perpendicular to its web of 2.34 inches. Only this radius of gyration need be considered as the flanges of the two channels are latticed together. For the ratio of the length L of the boom in feet to the radius of gyration r in inches

$$\frac{L}{r} = \frac{17}{2.34} = 7.2,$$

which is not excessive. The elastic limit for soft steel may be taken at 30,000 pounds per square inch. Dividing the

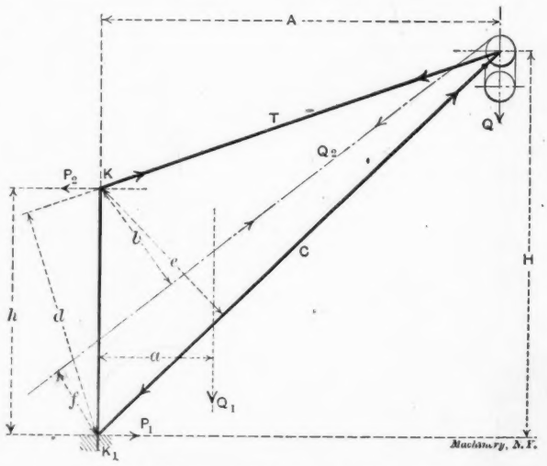


Fig. 2. Diagrammatical View of Pillar Crane

load on one channel by its sectional area the actual unit stress will be

$$\frac{14{,}455}{2.38} = 6{,}075 \text{ pounds,}$$

which shows that two 6-inch × 8-pound channels are quite sufficient to stand the load.

Stresses in the Tie-bars

To find the tensile stress in the tie-bars the same method as just explained will be used. Taking K_1 as a center of

* For previous articles on cranes, crane design, and efficiency of crane mechanism, see MACHINERY, January, 1909, engineering edition: Design and Construction of Electric Over-head Cranes, and also the articles there referred to; see also MACHINERY'S Reference Series No. 23, Crane Design.

† Address: 1463 Kenwood Ave., Camden, N. J.

moments and referring again to Fig. 2, the moments of the external forces are:

Moment of $Q = M_o = QA$, (5)

Moment of $Q_1 = M_1 = Q_1 a$. (6)

Moment of $Q_2 = M_2 = -Q_2 f$. (11)

Dimension f is found by scaling to be 2½ feet.

Substituting the values in these formulas:

$M = 10{,}000 \times 13 = 130{,}000$ foot-pounds,

$M_1 = 5{,}000 \times 3\frac{1}{4} = 16{,}250$ foot-pounds,

$M_2 = -5{,}000 \times 2\frac{1}{2} = -12{,}500$ foot-pounds,

and the sum M_s of these moments is

$M_s = 130{,}000 + 16{,}250 - 12{,}500 = 133{,}750$ foot-pounds. (12)

The moment M_1 of the internal stress T in the tie-bar is

$$M_1 = Td. \quad (13)$$

Dimension d scales 7½ feet.

Since M_1 must be equal to M_s

$$Td = M_s \quad (14)$$

and transposing:

$$T = \frac{M_s}{d} \quad (15)$$

Substituting the values in formula (15) the tensile stress in the tie-bars is: $T = \frac{133{,}750}{7\frac{1}{2}} = 17{,}830$ pounds.

As there are two tie-bars the load on one is $\frac{17{,}830}{2} = 8{,}915$ pounds. Using a safe fiber stress of 10,000 pounds per square inch, the area of one bar $= \frac{8{,}915}{10{,}000} = 0.892$ square inch with the corresponding diameter of 1 1/16 inch.

Stresses in Pillar

The stresses in the pillar are due to the bending moments of the loads Q and Q_1 and to the direct vertical loads Q and Q_1. The bending moment of Q and Q_1 was found by formulas (5) and (6) to be 130,000 foot-pounds and 16,250 foot-pounds, respectively. The sum of these moments is

$M_s = M + M_1 = 130{,}000 + 16{,}250 = 146{,}250$ foot-pounds (16)

or 1,755,000 inch-pounds. This bending moment in inch-pounds must be equal to the product of the section modulus of the pillar cross-section, times the safe unit fiber stress. Considering the sectional area of a hollow cylinder for the cast iron pillar, the section modulus is

$$S = \frac{\pi (D^4 - d^4)}{32D} \quad (17)$$

in which D = the outside diameter of the pillar, and

d = the inside diameter of the pillar.

Using a safe fiber stress $s = 3{,}000$ pounds per square inch, the above mentioned equation reads:

$$M_s = \frac{\pi (D^4 - d^4)}{32D} \times s \quad (18)$$

Assuming an outside diameter of 24 inches, the inside diameter d is found by transposing the formula (18):

$$d = \sqrt[4]{D^4 - \frac{32\, M_s\, D}{s\, \pi}} \quad (19)$$

and substituting the values:

$$d = \sqrt[4]{24^4 - \frac{32 \times 1{,}755{,}000 \times 24}{3000 \times 3.14}} = 20\frac{7}{8} \text{ inches.}$$

As mentioned before, not only the bending moment, but also the direct vertical loads Q and Q_1 must be considered. As the bending moment produces a tensile stress on one side of the column and a compressive stress on the other side, the additional vertical loads Q and Q_1 naturally increase the compressive and reduce the tensile unit stress somewhat.

The unit stress in the pillar caused by the vertical loads is

$$s_1 = \frac{Q + Q_1}{\text{Area}} = \frac{15{,}000}{110} = 137 \text{ pounds per square inch.} \quad (20)$$

110 square inches is the sectional area of the pillar at the dangerous section.

The sectional area of the pillar was calculated for a bending stress of 3,000 pounds. Adding the unit stress for the bending moment and the unit stress for the vertical loads, the actual compressive unit stress is found to be:

$3{,}000 + 137 = 3{,}137$ pounds per square inch. (21)

Subtracting the unit-stress produced by the vertical loads from the unit bending stress the actual tensile stress s_t in the pillar results:

$3{,}000 - 137 = 2{,}863$ pounds per square inch. (22)

Vertical Tie-rods

The vertical tie-rods, connecting the crosshead with the lower end of the boom, receive the vertical component of the tensile stress T in the ties, and the vertical component of the compressive stress C in the bocm, or what is the same, the added loads Q and Q_1.

$$Q_3 = Q + Q_1 = 15{,}000 \text{ pounds.} \quad (23)$$

in which Q_3 = the stress in the two vertical tie-bars.

Each of the two tie-rods receives half of this load or 7,500 pounds. Using a safe unit fiber stress of 10,000 pounds, the area of one tie-rod is $\frac{7{,}500}{10{,}000} = 0.75$ square inch, with a corresponding diameter of one inch.

Pintle

The reaction P_2 on the pintle (see Fig. 3) is caused by the loads Q and Q_1, whose moments about K must equal the moment of P_2 about the same center:

$$QA + Q_1 a = P_2 h = P_1 h \quad (24)$$

and this formula transposed and the values substituted

$$P_1 = P_2 = \frac{10{,}000 \times 13 + 5{,}000 \times 3\frac{1}{4}}{8} = 18{,}280 \text{ pounds} \quad (25)$$

The reaction P_2 produces a bending moment on the pintle, and referring to Fig. 3, this bending moment

$$M_b = \frac{P_2 L}{2} \quad (26)$$

in which L = the length of the pintle. Assuming the length $L = 1\frac{1}{2}\, D_1$, the formula (26) reads:

$$M_b = \frac{P_2 \times 1\frac{1}{2}\, D_1}{2}.$$

This moment has to be equal to the product of the section modulus of the sectional area of the pintle times the safe unit stress. The section modulus for a circular section being $\frac{\pi}{32} D_1^3$, and assuming the safe unit stress $s = 8{,}000$ pounds the equation reads:

$$\frac{P_2 \times 1\frac{1}{2}\, D_1}{2} = \frac{\pi}{32} D_1^3\, s \quad (27)$$

and transposing

$$D_1 = \sqrt{\frac{P_2 \times 1\frac{1}{2} \times 32}{2\, \pi\, s}} \text{ or} \quad (28)$$

$$D_1 = \sqrt{\frac{18{,}280 \times 1\frac{1}{2} \times 32}{2 \times 3.14 \times 8000}} = 4\frac{1}{4} \text{ inches approx.}$$

and $L = 1\frac{1}{2} \times 4\frac{1}{4} = 6\frac{3}{8}$ inches.

Besides the bending moment produced by the reaction P_2 the direct vertical loads Q and Q_1 also produce stress, and this stress per square inch is found by dividing the sum of the vertical loads by the sectional area of the pintle in square inches:

$$s_1 = \frac{10{,}000 + 5{,}000}{14.19} = 1{,}060 \text{ pounds per square inch.} \quad (29)$$

The maximum unit stress on the pintle is then:

$8{,}000 + 1{,}060 = 9{,}060$ pounds per square inch. (30)

Foundation Bolts

Considering an axis A-A in Fig. 4, which shows a plan of the base of the pillar, the sum of the moments of the overturn-loads Q and Q_1 about this axis must be equal to the sum of the resisting moments. The latter are due to the stress in the foundation bolts and to the weight of the pillar. This weight can easily be calculated as the cross-section of the

pillar is already known, and in this case is found to be: $Q_4 = 5{,}000$ pounds. The moments of the overturning loads with respect to axis *A-A* are:

$$M_4 = Q\ (A - n) \qquad (31)$$

or

$M_4 = 10{,}000\ (13 - 1\frac{1}{2}) = 115{,}000$ foot-pounds,

$$M_5 = Q_1\ (a - n) \qquad (32)$$

$M_5 = 5{,}000\ (3\frac{1}{4} - 1\frac{1}{2}) = 8{,}750$ foot-pounds,

in which n = distance of the foundation bolts from the center of the crane. In this case n is found by scaling to equal 1½ foot.

The sum of the overturning moments =

$$M_4 + M_5 = 123{,}750 \text{ foot-pounds.}$$

The resisting moments of the foundation bolts are:

$$M_6 = 2P_3n + (2P_3 \times 2n) \qquad (33)$$

in which P_3 equals the stress in one foundation bolt. The resisting moment of the weight Q_4 of the pillar is:

$$M_7 = Q_4n = 7{,}500 \text{ foot-pounds.} \qquad (34)$$

The sum of the resisting moments is therefore equal to

$$M_4 + M_5 = 2P_3n + (2P_3 \times 2n) + Q_4n \qquad (35)$$

and transposing

$$P_3 = \frac{(M_4 + M_5) - M_7}{6n} \qquad (36)$$

Substituting the value s, the stress on one foundation bolt

$$P_3 = \frac{123{,}750 - 7{,}500}{6 \times 1\frac{1}{2}} = 12{,}910 \text{ pounds.}$$

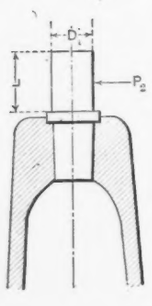


Fig. 3. Pintle of Pillar Crane

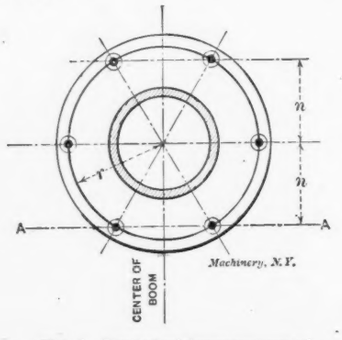


Fig. 4. Layout of Arrangement of Flange Bolts

Using a safe unit stress of 12,000 pounds, the area of one bolt is $\frac{12{,}910}{12{,}000} = 1.08$ square inch with a corresponding diameter of 1¼ inch.

[The calculation of the foundation bolts as here given is correct only on the assumption that the base flange of the crane and the bolts are made of inelastic materials. For a more fundamental treatment of the subject of foundation bolts, see MACHINERY, December, 1906, engineering edition: Flange Bolts (reprinted in MACHINERY'S Reference Series No. 22). For an article on the Working Strength of Bolts, which should also be considered in this connection, see MACHINERY, November, 1906, engineering edition. (Also reprinted in Reference Series No. 22).—EDITOR.]

Foundation

Referring to Fig. 1, we find the moments which tend to overturn the crane with its foundation about an axis passing through e to be:

sum of overturning moments =

$$Q\left(A - \frac{D}{2}\right) + Q_1\left(a - \frac{D}{2}\right) \qquad (37)$$

This sum of the overturning moments is resisted by the moment of the combined weights Q_5 of the foundation and the pillar:

$$\text{sum of resisting moments} = Q_5\frac{D}{2} \qquad (38)$$

The equation of moments therefore reads:

$$Q\left(A - \frac{D}{2}\right) + Q_1\left(a - \frac{D}{2}\right) = Q_5\frac{D}{2} \qquad (39)$$

and transposing

$$Q_5 = \frac{Q\left(A - \frac{D}{2}\right) + Q_1\left(a - \frac{D}{2}\right)}{\frac{D}{2}} \qquad (40)$$

assuming the diameter D of the foundation to be 9 feet and substituting the values:

$$Q_5 = \frac{10{,}000\ (13 - 4\frac{1}{2}) + 5{,}000\ (3\frac{1}{4} - 4\frac{1}{2})}{4\frac{1}{2}} = 17{,}500 \text{ pounds.}$$

Deducting from this combined weight of foundation and pillar the amount for the latter, we get the theoretical weight of the foundation:

$$17{,}500 - 5{,}000 = 12{,}500 \text{ pounds.}$$

Using a factor of safety of 3, the weight of the actual foundation must be:

$$12{,}500 \times 3 = 37{,}500 \text{ pounds.}$$

Having calculated the different parts of the crane as described it is good practice to test the pillar for its rigidity, as the amount of deflection must not be too great. The load on the unsupported end of the pillar was found by formula (25) to be $P_2 = 18{,}280$ pounds. The deflection N in inches is:

$$N = \frac{P_2h^3}{3\,EI} \qquad (41)$$

in which

h = the height of the pillar in inches = 96 inches.

E = the modulus of elasticity = 12,000,000 for cast iron.

I = the moment of inertia = $\frac{\pi}{64}(D^4 - d^4) = 7{,}257$.

Substituting these values we find the deflection

$$N = \frac{18{,}280 \times 96^3}{3 \times 12{,}000{,}000 \times 7{,}257} = 0.062 \text{ inch,}$$

or about 1/16 of an inch, which is not excessive.

* * *

INTELLIGENT USE OF LABOR-SAVING MACHINERY

It is one thing to use labor-saving machinery in order to permit rapid production and to conserve the energies of workmen, so as to produce a better product with greater rapidity, and quite another thing to use labor-saving machinery simply to avoid work. In one case there is economy of production, while in the other case there is wastefulness of production. An illustration came to our attention not long ago in the building of a fence in City Hall Park, New York. This fence is made of one-inch heavy pipe, supported in suitable posts. To prevent it being made a roosting place by loafers "anti-sit-downs" were fastened to the top rail with one-quarter inch stove bolts. To drill these holes, a portable gas engine and electric motor were provided to drive an electric drill. The cost of the outfit and a suitable charge for its depreciation undoubtedly made the cost of drilling the holes considerably greater than it would have been had they been drilled by improved breast drills, with power feed and chain support. These useful little tools are capable of putting a hole through a one-inch pipe in a very short time, and the cost of equipment is very low. Labor-saving machinery should be something more than "labor-saving"; it should be production-increasing and economical as well.

* * *

When the De Laval steam turbine was first brought into the market, the units were small and there was no condensing, and the result was a high steam consumption. Subsequent improvements, however, have tended to reduce the steam consumption so materially that this type of steam turbine now claims a place among the most economical motors. In referring to the figures below it should be borne in mind that the steam consumption refers to effective horse-power, while in many cases it is customary to give the steam consumption per indicated horse-power. One 500 horse-power turbine installed at Stockport, Great Britain, shows a steam consumption per effective horse-power of 13½ pounds per hour; another of 330 horse-power installed in St. Petersburg, Russia, shows a consumption of 12½ pounds per hour.

LOCOMOTIVE REPAIR SHOP PRACTICE - 2

THE C. M. & ST. P. R. R. SHOPS AT MILWAUKEE

ETHAN VIALL*

In this article, which is a continuation of the one published in the August number, the practice in the tool-room, boiler, and blacksmith shops will be specifically treated, and in addition descriptions of the tools and methods employed in connection with other branches of locomotive repair work will be given.

In the tool-room, which is in charge of Gust. Gstoettner, everything is neat and up-to-date as is evident by the illustration, Fig. 38, which shows the arrangement of the gear and milling cutter rack which is a model for any shop. Flue expander segments are all made in the tool-room, and the special mandrels used to hold the segments while they are being turned, are shown at *A*, Fig. 39; some of the unturned segments are shown at the right. At *B* is shown the way the segments are held together while being placed on the man-

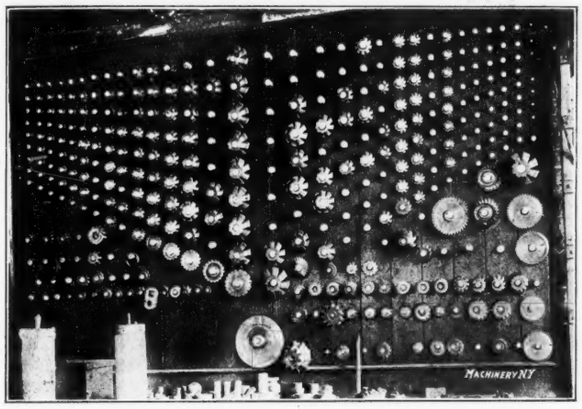


Fig. 38. Gear and Milling Cutter Rack in the Tool-room

drel. The clamping collar shown is removed as soon as the mandrel nut is tightened enough to hold the parts securely. At *C* are shown three sets of finished segments held together by heavy rubber collars until wanted for use. The steel from which these segments are made is bought already drawn to the right sectional shape. It is then cut up into the right lengths and the ends, beveled sides and narrow edge ground on the grinder shown in Fig. 40. A special clamping device, *A*, holds the parts while the ends are being ground and another clamp *B* holds them while the narrow edge is ground. The device used to hold them while grinding the bevel, is out of sight behind the wheel.

Boiler Shop Kinks

In the boiler shop the common pneumatic flue swage used in most railroad shops, has a rapid-stroke pneumatic welding swage or die, placed on one side as shown at *A* and *B*, Fig.

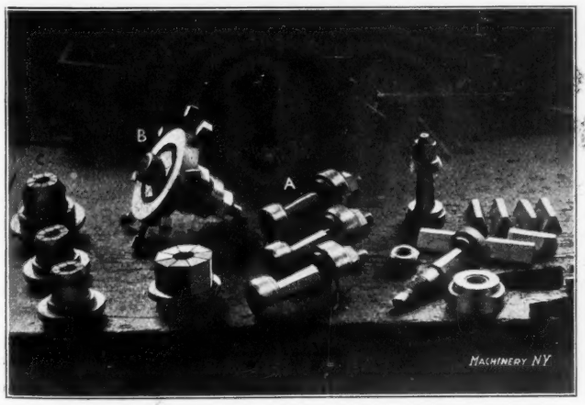


Fig. 39. Flue Expander Segments and Tools used in making them

43. After a new end has been placed on the flue and welding heat taken, it is placed in this die and the air turned on by means of the hand lever shown. The rapid blows complete the job in a hurry, and apparently do it just as well as the usual rolling device used for welding.

Ends of flues are cut off in the pneumatic trimmer, Fig. 41, and repair ends are cut off and one end beveled in the ma-

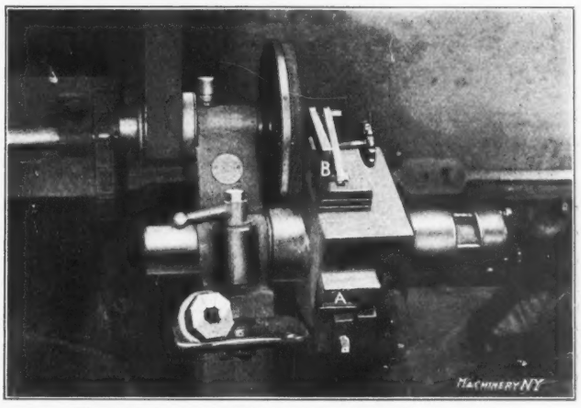


Fig. 40. Special Grinder for Flue Expander Segments

chine shown in Fig. 44. This machine has a two-jawed pneumatic chuck *A*, for holding the flue which is being cut into short pieces. The principle of the operation of this machine can be understood by examining this and the following engraving. The bevel on one end of the pieces is obtained by using a wide cut-off tool straight on one side and beveled at about 45 degrees on the other.

Fig. 45 is the same machine with a taper reamer placed in the pneumatic chuck *A*, for the purpose of beveling and removing the burr from the inside of the short piece of flue held by the hand clamping levers *C* and *D*. A large number of flue end repair pieces can be cut off and one end reamed in this machine in a very short time.

Assembling Springs

In the spring department of the blacksmith shop, springs are assembled and compressed ready for the band by the

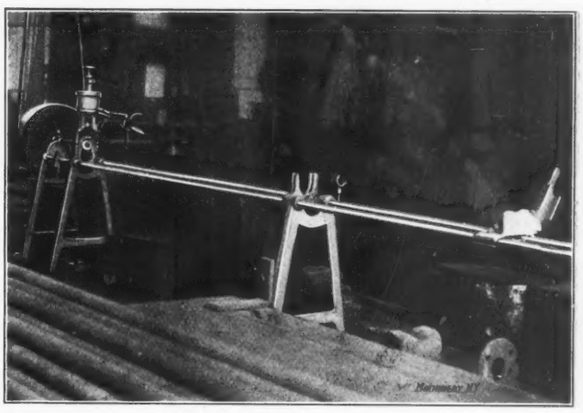


Fig. 41. Pneumatic Flue-cutter

clamps shown in Fig. 46. After the hot band has been slipped into place, the clamp is removed and the band and spring compressed in the steam bulldozer shown in Fig. 47. While the pressure is on, the sides of the band are hammered down closely onto the spring with sledges. Pressure is kept on the band until it is cool enough to hold the spring leaves firmly together.

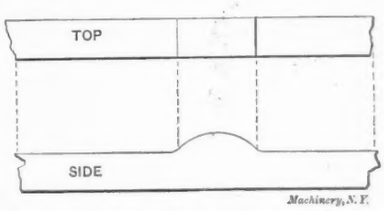


Fig. 42. The Way a Bar is upset in the Middle by a Bulldozer

Scrap metal is "baled" and then welded and forged into billets or slabs and then a number of these slabs are welded together, and forged into various locomotive parts. Fig. 48 shows nine of these slabs ready to be heated, welded and forged into a driving-axle under one of the big steam hammers.

* Associate Editor of MACHINERY.

Special Bulldozer Formers

Charles G. Juneau, who has charge of the blacksmith shop of the new car department, has some very unusual bulldozer forging and bending forms. The first piece of work here shown is really a forging job, but Mr. Juneau has contrived to do it in good shape on a bulldozer. The operation consists in upsetting the metal at the middle of a bar of iron which is afterward bent into a U-shape, the object being to give the piece more strength at the bend than would otherwise be the case, and allow for the stretching of the metal on the outside at this point. Fig. 42 shows the manner in which the bar is upset and shaped at the middle, and Fig. 49 shows how it is done, the piece in this case being intended for an axle hanger. To start with, the bar is heated at the middle for seven or eight inches; then it is placed in the machine and formed at one stroke by the ram shoving the bar against the stop *A*, which upsets it, after which the arm *B* wedges die *C* over against the other half *D*, completing the shape.

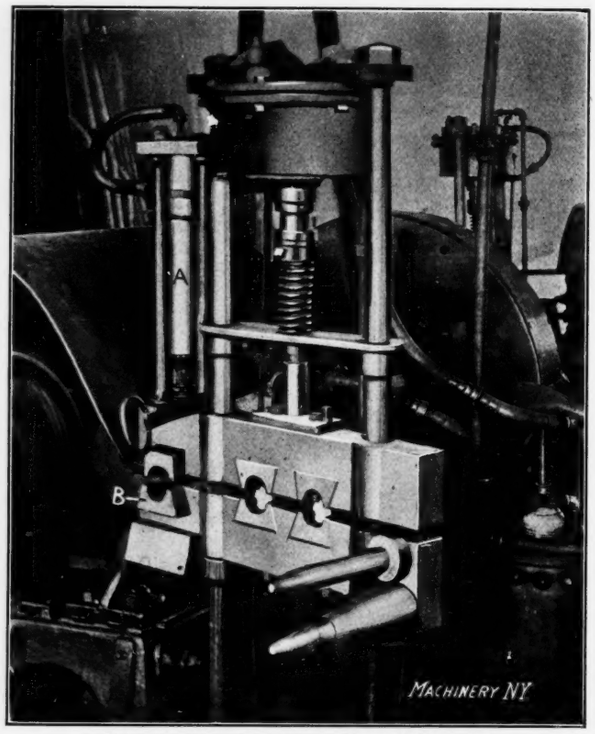


Fig. 43. Pneumatic Flue-swage and Welding Die

The bars used for swing hangers, are upset in the same way, and are then bent as shown in Fig. 50, the bar being shown at *F* just as the former is starting to bend it, and at *G* is shown the way it looks at the end of the stroke. The partially made swing hanger is now placed in the former shown in Fig. 51. This engraving shows the part with one end bent around and the forming ram in position for the bending of the other end. On the first stroke in this bender the end that is farthest from the ram, is bent up far enough to be out of the way as the other end is bent around. As the metal is red hot, this bending up of the one end is easily done and as easily tapped back into place with a hammer, before placing it on the form for the final bend. The construction of this former is too clearly shown to need explanation, except that the part of the end of the forming ram, that is under the guard plate, is of practically the same shape as the part that shows, a roller being used on the contact parts of both sides of the end. The coiled spring is, of course, to keep the ram against the forming guide during the entire stroke. After the ends are bent to place, they are welded in the dies shown in Fig. 52, which are also used in a bulldozer.

Cylinder carrier brackets are cut to length, drilled and then shaped on the former, Fig. 54. A finished bracket is shown leaning against the end of the truck on which the former is placed. The bracket is located correctly in the bending form, by means of a hole drilled in the middle of the bar into which a pin in the form, operated by the small hand lever *A*, is inserted.

Eye-bolts are formed at one stroke, in the former shown in

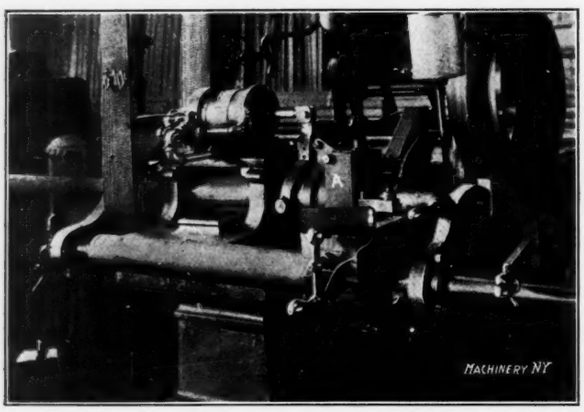


Fig. 44. Machine for Cutting and Beveling Flue Repair Ends

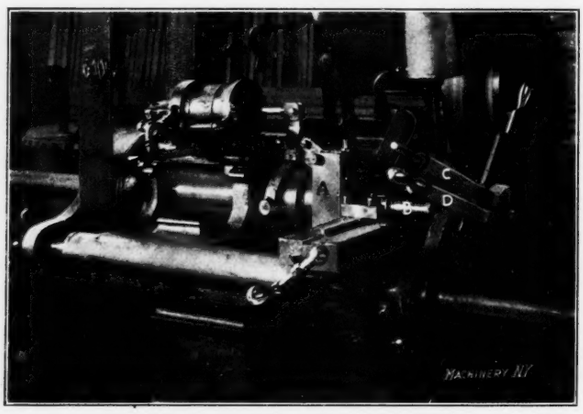


Fig. 45. Reaming out the Flue Repair Ends

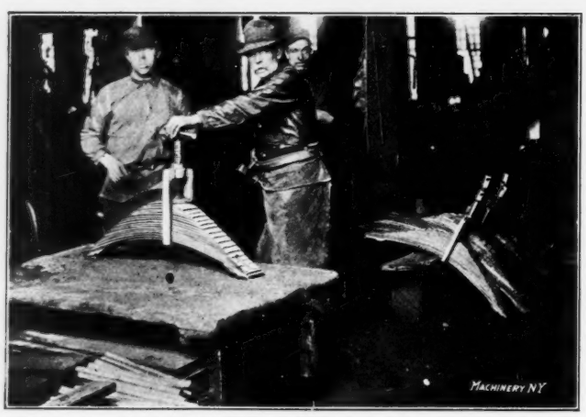


Fig. 46. Compressing a Locomotive Spring before the Band is put in Place

Fig. 47. Compressing Spring Bands in a Steam Bulldozer

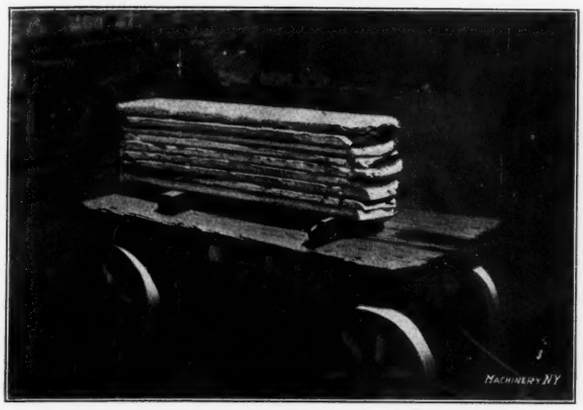


Fig. 48. Steel Slabs to be welded and forged into a Driving Axle

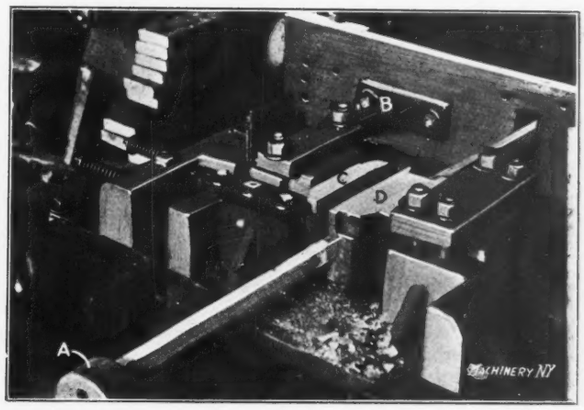


Fig. 49. Bulldozer for Upsetting a Bar, as indicated in Fig. 42

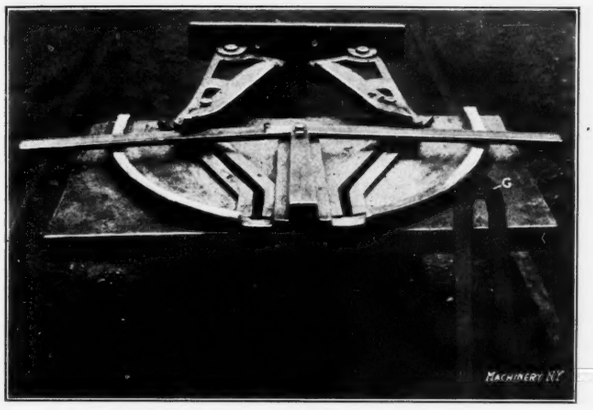


Fig. 50. Former for Making Swing-hangers

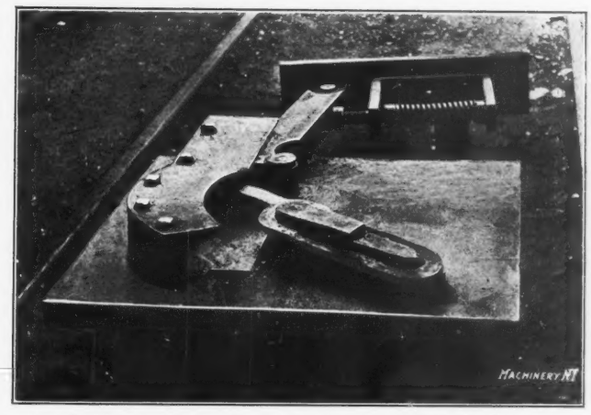


Fig. 51. Completing the Bending Operation on a Swing-hanger

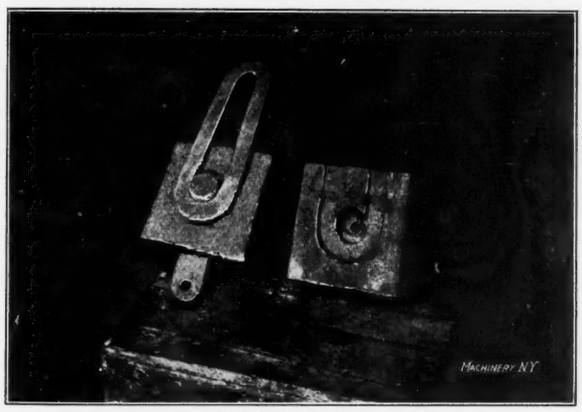


Fig. 52. Die used in Welding the Ends of Swing-hangers

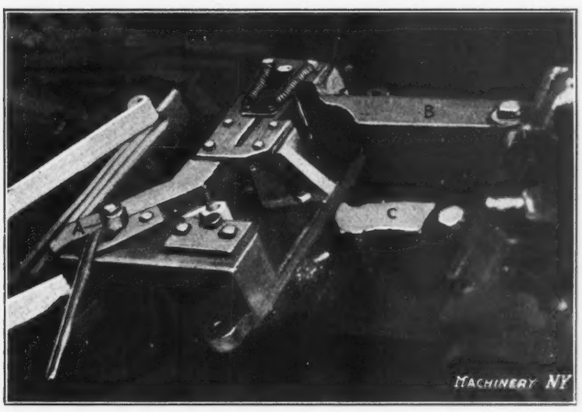


Fig. 53. Machine for Forming Hinges

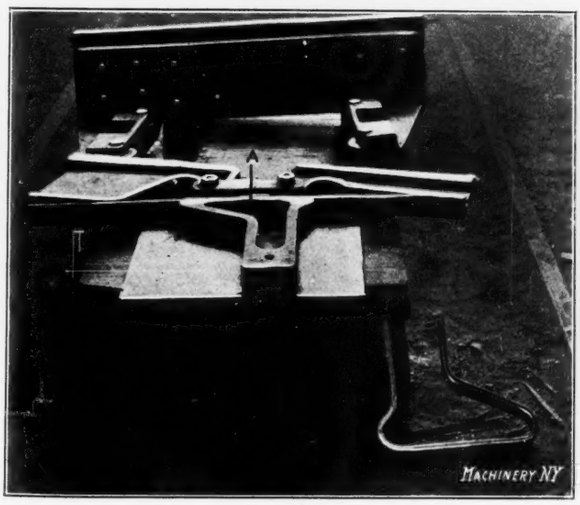


Fig. 54. Forming a Cylinder Carrier Bracket

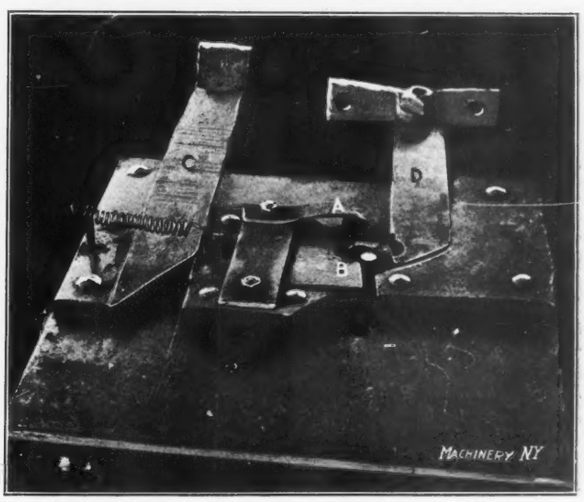


Fig. 55. An I-bolt Former

Fig. 55. The rod from which the eye-bolt is to be made, is heated and thrust in against the stop *A*, and on the stroke of the bulldozer ram, the part *C* being longest, pushes or wedges the part *B* over, forming a part of the eye. Part *D* next strikes the projecting end of the rod, bends it part way around and then coming in contact with the bevel, shoves it over, completing the eye. The recess *B* is intended to be used when connecting a chain to the eye-bolt, the end link of the chain being slipped into the recess and the end of the rod passed through it and bent as usual.

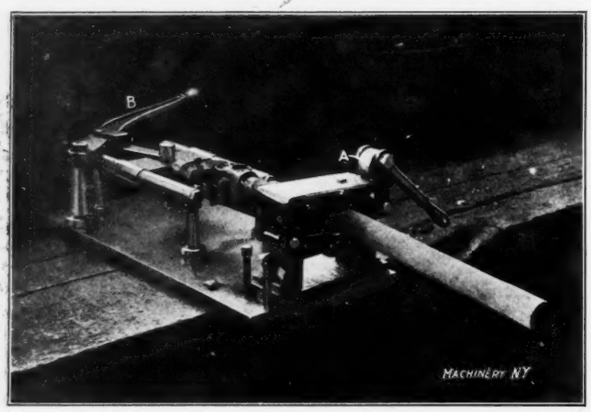


Fig. 56. Tool for Pressing Air Hose Couplings into Place

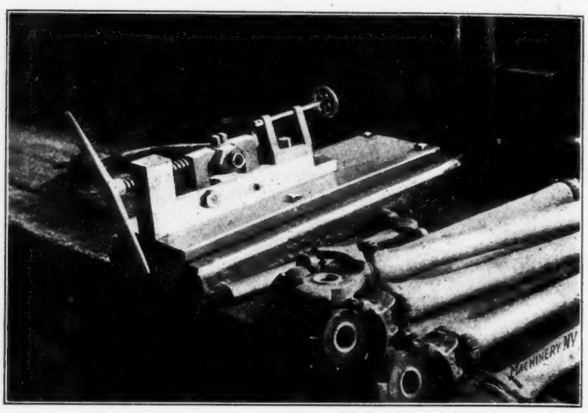


Fig. 57. Tool for Compressing Air Hose Clamp Collars

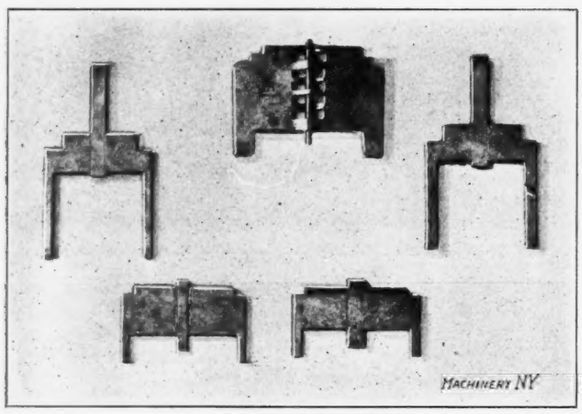


Fig. 58. Air Valve Lift Gages

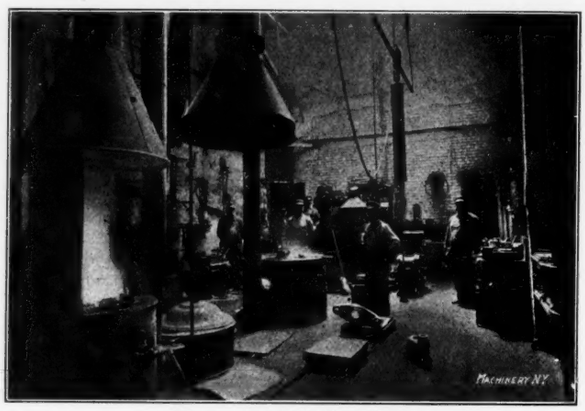


Fig. 59. The Babbitting Room

Fig. 53 shows how hinges are made, which is very similar to the forming of an eye-bolt. The bar heated on the end, is placed in the former and locked by the eccentric hand lever *A*. On the stroke of the ram the hinged piece *B* shoves the cross-slide over, pushing the end of the bar around the form pin far enough for the part *C* to catch it and complete the bend, the final motion of the part *C* being exactly the same as that of the corresponding piece on the eye-bolt bender.

Repairing Air-brake Couplings

Air-hose couplings are forced into the ends of the new hose lengths in the little device shown in Fig. 56. The hose is held and locked by the eccentric lever *A* and the coupling is shoved into place by pulling on the lever *B*. The locking collars are compressed, while the bolt and nut are put in place and tightened, in the clamping device shown in Fig. 57.

The gages used to measure the amount to take off of the

Fig. 60. Babbitting the Side of a Driving-box to Compensate for Wear

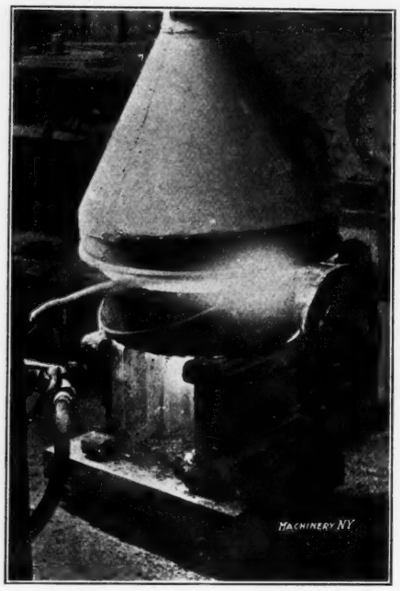


Fig. 61. Heating the Driving-box preparatory to Babbitting

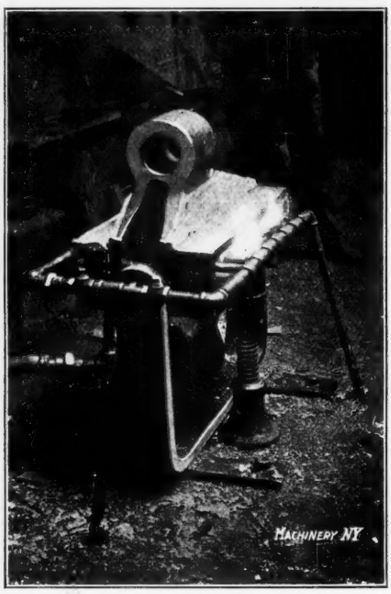


Fig. 62. Heating a Cross-head preparatory to Babbitting

plugs in a Westinghouse air pump, in order to allow the proper valve lift, are shown in Fig. 58. These gages are of a simpler form, but made on the same principle, as those shown in Fig. 33 (page 662), of the May number. The movable slide in the center is made of such a length, that when the shouldered end is placed in the plug opening and the center piece pushed down on top of the valve, the distance from the other end of the slide, to the ends of the fork, indicates the length the plug should be from its shoulder to its end, in order to allow the valve to lift just right. Friction alone is depended upon to hold the slide of the gage in whatever position it is set.

Babbitting Jigs

The babbitting room, Fig. 59, is a very complete little department all by itself, but under the general supervision of the machine shop foreman. Fig. 60 shows the way the sides of the driving-boxes are faced with babbitt. A special ring is laid on the box, and two pieces held in place by a loop spring, completes the "mold." Babbitt is then poured into this mold and the job is done. Before using this mold, however, the box must be heated and tinned on the side in order to make the babbitt stick properly. The heating is done as shown in Fig. 61. The driving-box is placed on a little four-wheeled iron truck and run under a big hood. A pan containing burning coke is then set on top and the heat forced down onto the side of the box by an air blast as shown. After being sufficiently heated, the coke pan is removed, the truck pushed along a short distance, and the end of the box tinned with solder and the babbitt put on as already shown.

Fig. 62 shows the heater used to heat crossheads previous to putting on the babbitt liners. These liners are molded by clamping an iron band around the edge of the surface to be babbitted, which has been previously tinned, the whole process being similar to the way the driving-boxes are babbitted.

Metallic packing is made in a department in charge of Mr. Edwards, who has been with the company nearly forty years and has patented a number of things now in common use on railroads. Fig. 63 shows a set of Edwards piston-rod packing rings, and the three molds used to produce them. Another set of packing molds and a sprue cutter are shown in Fig. 64.

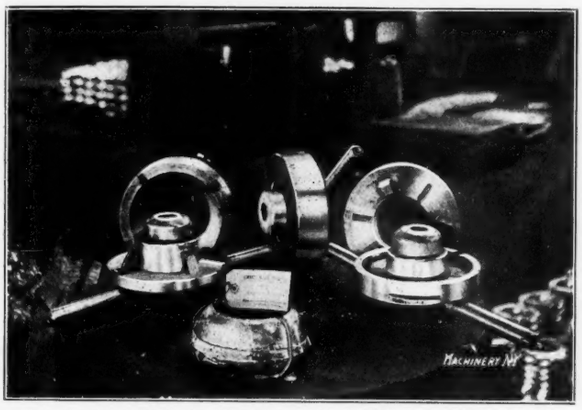


Fig. 63. Metallic Packing for Piston-rods and Molds in which it is cast

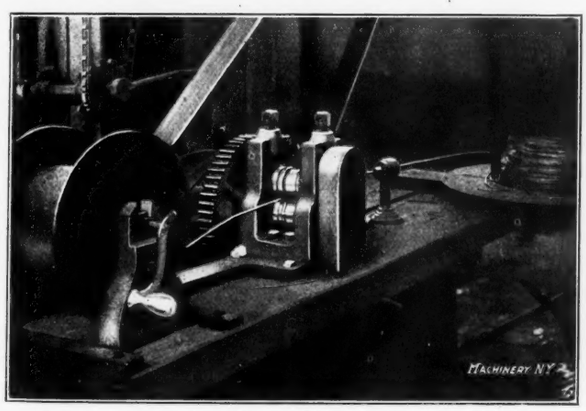


Fig. 65. Rolls for Flattening and Sizing Copper Wire for Gaskets

Wire Gasket Practice

Considerable difference of opinion exists in various railroad shops as to the best method of making or applying copper wire gaskets for dome covers and steam chests, some lapping and brazing the ends and others just butting them together. Mr. Edwards' method is to first run the wire through flattening rolls, Fig. 65, in order to give it a uniform thickness, and then to force the wire edgewise into a groove cut for the purpose. Fig. 66 shows a dome cover in which a gasket has been inserted in this way. The ends of the gasket are beveled to about 45 degrees and are fitted closely together in the groove, but not brazed or soldered in any way.

* * *

PURE AIR LAW FOR WORKMEN

C. M. RIPLEY*

The new labor law requiring a supply of fresh air for employes of work-shops and factories, reads as follows: "The owner, agent or lessee of a factory shall provide, in each workroom thereof, proper and sufficient ventilation; if excessive heat be created or if steam, gases, vapors, dust or other impurities that may be injurious to health be generated in the course of the manufacturing process carried on therein, the rooms must be ventilated in such a manner as to render them harmless, so far as is practicable."

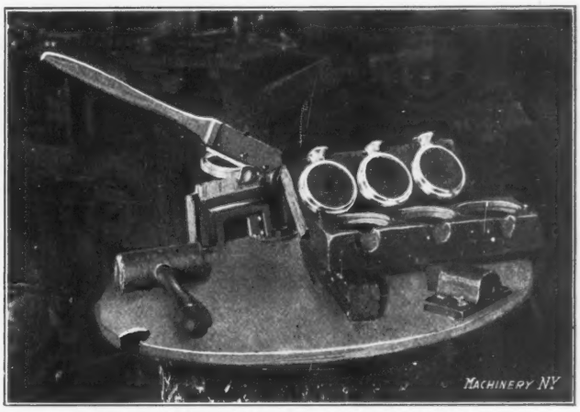


Fig. 64. Other Packing Molds and a Sprue Cutter

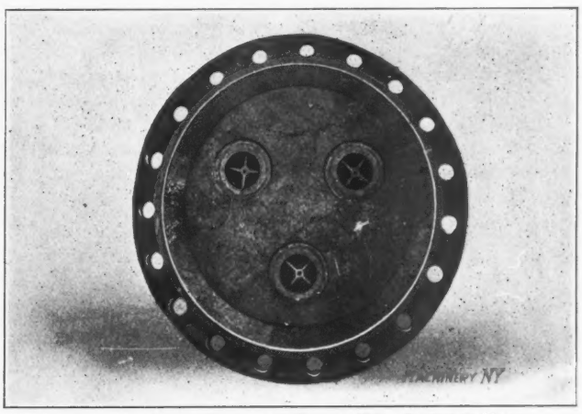


Fig. 66. A Dome Cover with Copper Wire Gasket in Place

Mr. William W. Walling, chief factory inspector for the state of New York, interprets the law as follows:

"As defined by Dr. John S. Billings, perfect ventilation means that any and every person in a room takes into his lungs at each respiration, air of the same composition as that surrounding the building, no part of which has recently been in his own lungs or those of his neighbors, or which consists of the products of combustion generated in the building, while at the same time he feels no currents or drafts of air, and is perfectly comfortable as regards temperature, being neither too hot nor too cold. How much air is required to meet these conditions? Not less than 2,000 cubic feet per hour for each person, with the same amount per hour for each cubic foot of gas consumed whether for light, heat or power."

* Address: 45 W. 34th St., New York City.

Is this Amount Arbitrary?

Some landlords in New York City have put forth the claim that the amount of fresh air specified by the Department of Labor is an "arbitrary quantity." Several authorities on the subject of ventilation who have been consulted in the matter and who are also entirely disinterested agree that 2,000 cubic feet per hour per person is common practice and is based upon definite laws or rules which have been followed for many years in the design of ventilating systems.

The Architects' and Builders' Pocketbook, compiled by Mr. Frank E. Kidder, states that 1,800 cubic feet per hour per child should be the standard for school buildings, this amount being required by law both in Massachusetts and New York. It further states that in buildings more closely packed, and occupied for a longer period, the air supply should be from 2,000 to 2,500 cubic feet per hour per person. In giving an example of a school-room of certain dimensions, he shows that the standard amount of air would result in the air in the room being changed about eight times per hour, which certainly does not appear to be an excessive amount.

Since the above applies only to buildings where people sit quietly, or for buildings where only children congregate, it is difficult to see how the New York Department of Labor can justly be accused of an "arbitrary" action.

Mr. Percival Robert Foses, consulting, heating and ventilating engineer of New York City, states that he has found the rate of 2,000 cubic feet per hour per person a satisfactory and conservative working basis. This was used in designing the ventilating equipment of the large department store of B. Altman & Co., in the Rikers Island Penitentiary, in the Baltimore Stock Exchange, and in the new Hearst Building at San Francisco, as well as in others; and he stated that the operating expense for a system laid out on this basis has not been found excessive, and will not be if due care is taken at the time of installation.

Example of a Loft Building

In a loft 25 feet wide and 100 feet long, containing 80 workmen, and lighted with electricity, the amount of air required would be 80 times 2,000 = 160,000 cubic feet per hour. This amount of air per hour would move at the rate of about ⅛ mile per hour, and would be sufficient to change the air in the loft six times per hour, assuming a ten-foot ceiling. Since the Massachusetts and New York State laws for school rooms require eight changes per hour and since some authorities recommend even 50 per cent in excess of this, it appears that the action of the factory inspector hardly comes within the definition of the word "arbitrary."

Gas Lighting

Dr. Daniel R. Lucas of New York City states that it is a well-known law of hygiene that one gas jet will consume as much oxygen as five persons. Since electric lighting, thanks to the new high efficiency lamps, has been reduced in cost 50 per cent or more, it appears that the easiest way to comply with the labor law regarding ventilation would be to abandon gas lighting. In New York City especially this would seem advisable, as electricity can be bought by meter from the street or from the power plant downstairs.

Since the vitiating effect on the air of the average gas light is equivalent to that of five persons, it can be readily seen that the ventilation required will be reduced 5/6 by abandoning gas light, assuming one gas jet to each workman, or, stating it in another way, the landlord who clings to gas lighting must install ventilating apparatus six times as large as would be necessary if electric light were used. This calculation is also based upon conditions where one gas jet is provided for each workman.

Operating Costs

The operating cost for a ventilating system is made up of two items: (1) Power for turning fans; (2) Additional heat for incoming air. In a loft building where the tenant will pay for the power, and the landlord will pay for the extra heat required, since heat is included in the rent, the expense will be divided automatically. It will here be noticed that the adoption of electric lighting will cut down the operating expenses to a remarkable degree. This cut in expense will benefit the tenant, since a much smaller ventilating motor will be required, and it will also benefit the landlord because less air will have to be drawn in, and hence the cost for heating will be diminished.

In large systems the services of an expert heating and ventilating engineer would probably prove valuable, and it is possible to so design the equipment that a judicious "recirculation" of the air from halls and basements will effect an economy in the fuel bill. This air is seldom impure and requires much less heat than if cold air were brought in from outside. It is also possible in buildings where high pressure steam is available, or where boilers which have been run at low pressure steam can be run at a high pressure, to adopt the following policy: Provide steam engines to operate the fans and turn the exhaust steam into the heating coils, thus getting a double use out of the steam and cutting down the electricity bill. This idea could be carried still further in many instances, and economies could be made (especially in the winter) by abandoning electric pumping, and again reducing the expense for electricity. This is the stock argument of the advocates of isolated plants, who contend that great economies result in buildings of a million cubic feet or more, if engines are installed and electricity is made on the premises. It is a fact that steam at high pressure contains only about 6 per cent more heat than steam at low pressure. Thus the argument that electricity can be made and a building heated with exhaust steam, is advanced. The layman does not appreciate one very peculiar fact about steam: that at 5 pounds pressure it is only about 6 per cent cheaper to make than at 100 pounds pressure, showing that the cost does not increase in proportion to the pressure.

In the future it is probable that factories and loft buildings will be equipped with ventilating apparatus at the outset, with the ducts concealed in the walls and the fans located in the basement. A model building of this character has recently been completed at 37-43 West 26th St., New York City, in which the landlord at the time of construction had the ventilating system installed at his expense, after the design of a prominent consulting engineer. Thus the cost of operating a system and the responsibility of maintaining it in good condition does not rest upon the tenant. At the present writing (June 17) we are informed that the owners of the West 26th St. corporation, with offices at 725 Broadway, have already rented eight out of the twelve floors, a flattering reception and appreciation of the advantages they have to offer.

Importance of Pure Air in the Industries

In the report of the United States Bureau of Labor at Washington, D. C., it is shown that deaths among factory workers due to consumption were divided as follows:

Employes exposed to metallic dust	36.9 per cent
Employes exposed to mineral dust	28.6 per cent
Employes exposed to vegetable fiber dust	24.8 per cent
Employes exposed to animal and fiber dust	32.1 per cent

It was also shown that the highest consumption mortality existed among operators of grinders, and 49.2 per cent of all deaths were from that disease.

An ingenious conclusion was reached by Mr. Frederick L. Hoffman of the Prudential Life Insurance Co., based on this report. It is his opinion that by intelligent methods of ventilation and dust removal the consumption death rate among the wage earners could be so reduced as to result in an annual saving of 22,238 lives. This would add, quoting the *Engineering News*, "15.4 years of life for every death from consumption avoided by rational conditions of industrial life." Such a gain would represent a total of 342,465 years of additional life, and by just so much the industrial efficiency of the American nation would be increased. Placing the economic value of a year's life time at only $200, the total average gain to the nation would be $3,080 for every avoidable death of a wage earner from consumption, representing the enormous total of $68,493,000 as the annual financial value clearly within the range of practical attainment. Therefore, nothing within reason should be left undone as a national, state, individual, or social duty to prevent that needless but now enormous loss of human life from consumption due to the unfavorable conditions in American industry.

MAKING SOLDERLESS CANS FOR FOOD PRODUCTS

RALPH E. FLANDERS*

For a number of years, in riding out of New York on the "Shore Line," the writer has noticed on the right-hand side of the track, shortly after leaving Mt. Vernon station, an unusually neat and attractive group of shop buildings. The sign on the roof of the main building reads "Max Ams Machine Co." with some supplementary reference, which escapes the memory at the moment, relating to a process of manufacturing a sanitary, solderless can. While he has seen this

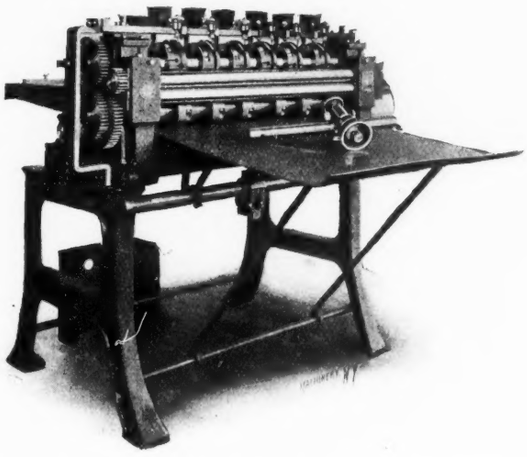


Fig. 1. Slitting Rolls with Double Cutting Edges and Self-contained Grinding Attachment

sign for several years, and has always felt a twinge of curiosity at each passage, it was only within the past few weeks that he embraced the opportunity to become acquainted with the men who are working at this place and with the work which they are doing.

The product of the shop and the methods of manufacture were found to be fully as interesting as the exterior gave promise of. Besides the line of work indicated by the sign, which now forms but a small part of the firm's output, the shop was found to be building a general line of tools for sheet metal working. There was evidently also a lot of contract work of various kinds going through the shop, both special machinery and tools, and it was evident that the mechanics here stand ready to tackle any job in sight in the line of small and medium metal working, taking particular pleasure in undertaking stubborn problems that have long resisted solution.

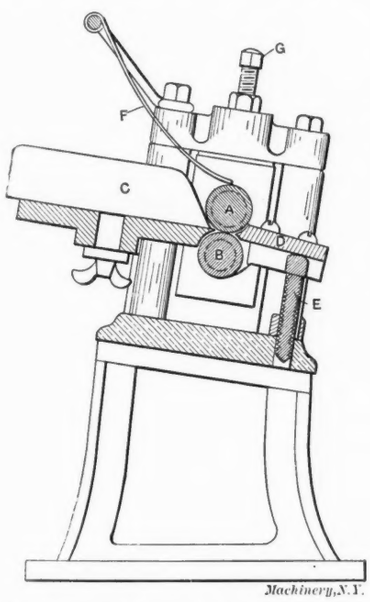


Fig. 2. Two-roll Bending Machine with Simple Adjustment for Radius of Curvature

The Ams Sanitary Can

But to get back to the sanitary cans. While this is now but a small portion of their work, it is a most interesting one, and with the permission of Mr. Ams some of the methods and machinery employed by this process are here illustrated and described. This system undertakes to make a can hermetically tight without the use of solder, brazing of any sort, or heat, the process being a cold one. This statement refers strictly to the sealing of the top and bottom of the can. The side seam is a new lock-seam which prevents any solder from the outside of the can body entering the interior of the can. The inside of the can is absolutely free from solder or acid, and a process which does not employ acids or other fluxes, or solder of any kind, has immense advantages from the sanitary standpoint.

Making the Body of the Can

The making of the body of the can will first be described. This does not differ materially from the process usually followed. Sheets of tinplate are first run through slitting rolls, such as shown in Fig. 1, and cut into strips of the proper width for the body of the can to be made. After thus being passed through lengthwise, the adjustment of the rolls may be altered, and the strips passed through again crosswise, thus cutting them into blanks of the size required.

Two or three improvements in the construction of these slitting rolls may be noticed. In the first place the cutters themselves are provided with cutting edges on both sides. This is an advantage oftentimes in setting them for work on narrow strips; and giving two edges in place of one doubles the life of the cutters as well. The principal improvement in the construction, however, relates to the sharpening of the cutting disks, which is done while they are in place in the machine. The attachment for performing the operation is seen on the receiving table in the illustration. It is a cup emery wheel, driven by a belt from an overhead drum and mounted on the swiveling holder seen on the bar beneath the

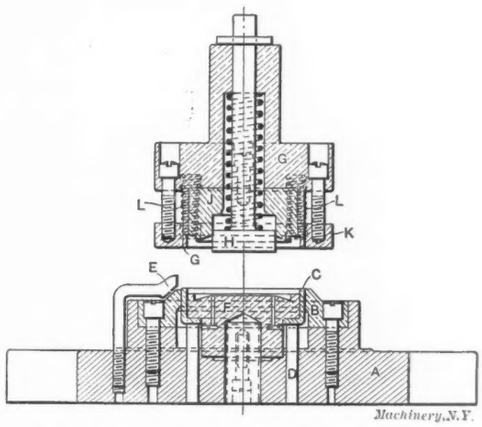


Fig. 3. Compound Punch and Die for Turning Can Cover shown in Fig. 4

table. By swinging this table down out of the way and dropping the delivery rolls, the disk cutters are exposed to the action of the emery wheel and the sharpening can be proceeded with expeditiously and effectively.

After thus cutting the blanks to the proper dimensions, they are bent into cylindrical form by the rolling machine, shown in Fig. 2. This has but two rolls in place of the three often used for such work. The blank is fed from the table *C* between rolls *A* and *B*. After passing through, the edge passes the guide plate *D* and is by it turned up about roll *A*. The radius of the curvature thus produced is regulated by adjusting screw *E*, which rocks guide plate *D* about the axis of roll *B*. This machine takes the blanks as fast as a dexterous operator can feed them between the rolls.

The soldering of the side seam may be done by hand with special fixtures, or on any of the commercial machines provided for the purpose. The makers have developed an automatic machine for this work in which the cylindrical sheets are placed by hand on a series of forms, which are indexed about a vertical spindle. As they are being pressed on the forms the edges pass under brushes which lay on the acid flux. The next indexing of the spindle brings the work to the soldering iron, where strips of solder are laid along the seam, being cut off and smoothed on by a mechanically operated iron, heated by gas. In the third position the work is allowed to cool, and in the fourth it is removed from the form, leaving it ready for the next piece.

* Associate Editor of MACHINERY.

The final operation on the body of the can is that of flanging to the form shown in the sketch at *A* in Fig. 4. This flanging is done in a simple and obvious way by inserting the work in rolls, which rotate it and turn up the edge as it revolves.

Making the Covers

The can covers are blanked and formed from the sheet in a single operation by a double action die, shown in Fig. 3; the shape given to them is indicated in the upper left-hand corner in Fig. 4. A sheet is laid in the die against stop *E* in

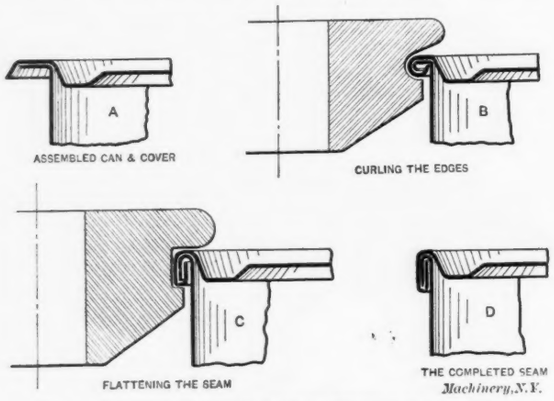


Fig. 4. The Sequence of Operations followed on the Double Seaming Machine

Fig. 3. The descent of the punch cuts out the blank between die *B* and punch ring *G*. The continued descent of the ram holds this blank firmly between *G* and pressure ring *C*, which is supported on pins *D*, which, in turn, are acted on by heavy rubber springs beneath the bed of the press. The spring plunger *H* also serves to hold the blank on the inside against

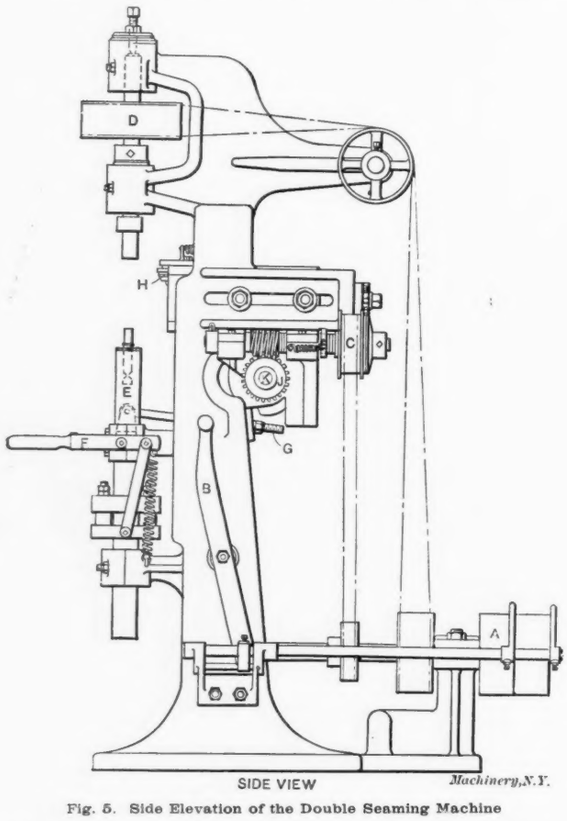


Fig. 5. Side Elevation of the Double Seaming Machine

forming die *F*. Pressure ring *K*, supported by springs *L*, has been holding the stock meanwhile. The blank thus cut out and held, is formed between dies *J* and *F* and ejected on the up stroke by the springs acting on members *C*, *H* and *K*.

As mentioned, the forming of the joint between the cover and the body is a cold process. It would be difficult to make this joint tight on a metal to metal fit, a leak being liable to occur near the seam of the body. To prevent this, the can covers are fed into an automatic machine, which deposits a very thin coating of an odorless and harmless compound in the groove of the cover, where the joint is made. This machine, which we are unable to show here, is simple and effective, and furnishes the means for rendering the can absolutely air-tight.

The Double Seaming Operation

The bodies and the covers are now ready for the seaming machine, in which is incorporated the basic feature of the process. In the old process, the can cover is made with a flange, fitting the body and soldered to it by an automatic process. In this case, however, the body and the can are rolled together into a double-lock seam by the series of operations indicated in Fig. 4. The can and cover are shown assembled at *A*. At *B* they are supposed to be held together and revolved rapidly in front of the first forming roller, which curls up the lips of the body and cover as shown. This roller then retreats and the second one comes up, flattening the seam firmly and neatly, as shown in progress at *C*, giving a result like that shown at *D*, where it is, however, shown somewhat loosely joined to more plainly indicate the construction. The seam is an exceedingly straight and neat one, and is rendered hermetically sealed by the lining process for the cap, previously described.

The machines for performing this seaming operation are shown in detail in Figs. 5 and 6, and in elevation in Figs. 7, 8

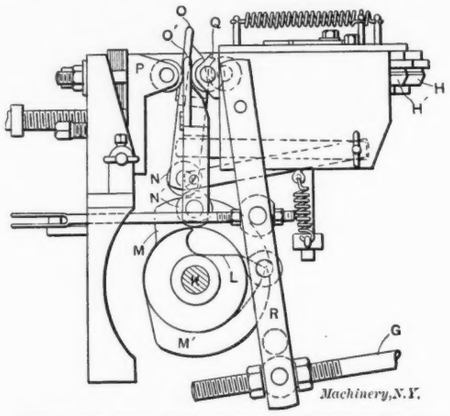


Fig. 6. The Cam Mechanism of the Seaming Machine

and 11. The can body is placed on a face-plate pivoted on spindle *E*, on which it loosely revolves. A similar face-plate is keyed to the upper spindle, driven by pulley *D* from driving pulley *A*. The cover and body are held together between these two face-plates, the pressure for this purpose being applied to spindle *E* either by hand or automatically, as will be described. As soon as this pressure is applied the can commences to revolve rapidly. The two rollers are in the position shown at *H* in Fig. 5, side by side. The mechanism for actuating them is shown more plainly in Fig. 6, which represents a view taken from the opposite side of the machine from that shown in the previous illustration.

The cam-shaft *K* (driven by worm-gearing *J* and pulley *C*, see Fig. 5) carries cams *L*, *M* and *M'*, which respectively operate levers *R*, *O* and *O'*. Lever *R*, by means of reach rod *G*, automatically raises spindle *E*, clamping the can and starting it to rotating. Levers *O* and *O'*, which are provided with wedge faces at their upper ends, as shown, enter one after the other between rolls mounted in back-stop *P* and slides *Q*. The latter furnish the support for rolls *H* and *H'*, which are thus brought successively into operation, forming the seam as shown in Fig. 4. The cam mechanism stops at the completion of the operation, and is started again by the operator when the work has been removed and new pieces placed in the machine.

In Fig. 7 is shown a machine of the same construction, but provided in addition with an automatic feed, the nature of which will be readily understood from the engraving. The cans are fed between guides on the work-table, as shown, from which they are advanced step by step by a pair of holders on each side, which advance, seize the cans, move them up into place between the spindles, open out and retreat for an-

other hold. An automatic ejector is also provided for removing the work from between the face-plates.

By the means just described, the cans are provided with a body and a bottom. They are now filled with the product for which they are to be used. It should be noticed that this

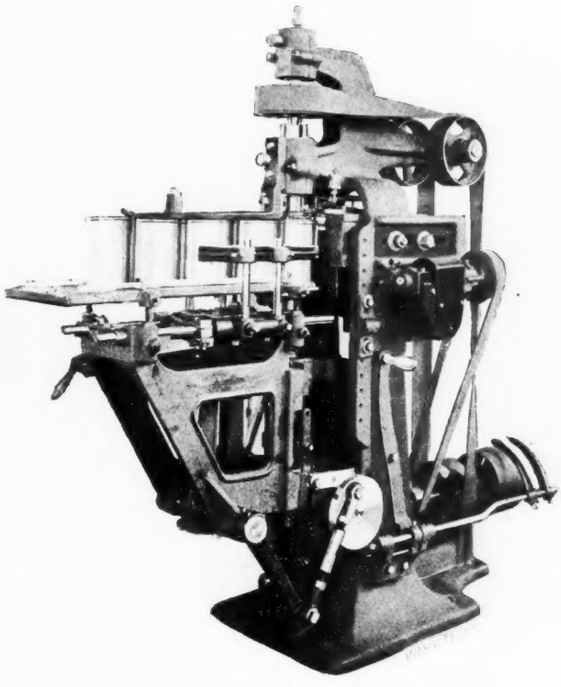


Fig. 7. Automatic Double Seamer for Cans for Food Products, from the One Pound to the One Gallon Size

filling is done through the full opening in the top of the can, instead of through a small opening in the cover, as is usual in soldered cans. This permits filling without special machinery, and without waste from slopping over outside of

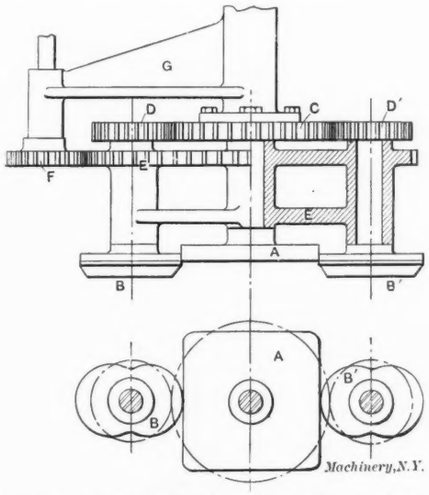


Fig. 9. Principle of the Machine shown in Fig. 8, when used for Square Cans

small openings. It also permits the easy canning of bulky materials, such as large fish, fruit, etc. After filling, the cans are again put through the same machine, and the cover is rolled and seamed into place by the same process, without the use of acids and solders, as previously described.

Seaming Machines for Square and Irregular Cans

A modification of this seaming machine is shown in Fig. 8. This operates on the principle illustrated in Fig. 9. In this machine, the can, instead of revolving, is held stationary, while the rolls are rotated and run around the edge. This is done sometimes for round cans where it is not desired to rotate the can, and it is the method always followed for square and irregular shapes of cans. The principle of the device as applied to a square can is shown in Fig. 9. *A* is the stationary can, and *B* and *B'* are the first and second rollers. It will be seen that these are of a contour to match the outline of the can *A*, when their centers are rolled about it in a circle. The face-plate *A*, which presses down on the can, is stationary. The frame *E* is revolved about it by the pinion *F*, meshing with gear teeth *E*. Journals are formed

Fig. 8. Automatic Double Seamer for Large Cans for Meat, Fruit, or Paint, up to Five Gallon Size

in *E* for the spindles, which carry rolls *B* and *B'*. The upper ends of these spindles carry gears *D* and *D'*, meshing with stationary gear *C*. It will thus be seen, that as frame *E* is revolved, rollers *B* and *B'* will also be revolved following the contour of the can and face-plate at *A*. The pitch lines of gears *D*, *C* and *D'* are shown in the lower diagrammatic view of Fig. 9.

Suitable means are provided in the machine shown in Fig. 8 for forcing first roll *B* and then roll *B'*, successively in against the work, and withdrawing them at the completion of the operation. A feed of somewhat similar construction to that of the machine shown in Fig. 7 is used. These machines work with surprising rapidity, tossing the cans off so

Fig. 10. An Assortment of Can Covers sealed by the Cold Process

fast that it would seem to be hard work to take care of them as they are delivered.

This last machine is not only adapted to round and square cans, but to irregular shapes of the greatest variety. A few of these are shown in Fig. 10. The American cans have been standardized to definite dimensions and capacities, and few

fancy shapes are found among them nowadays. The two covers shown at the left of Fig. 10 are of Italian origin, and doubtless exemplify the artistic instinct of the race, which will show itself in a can of preserved fish as readily as in

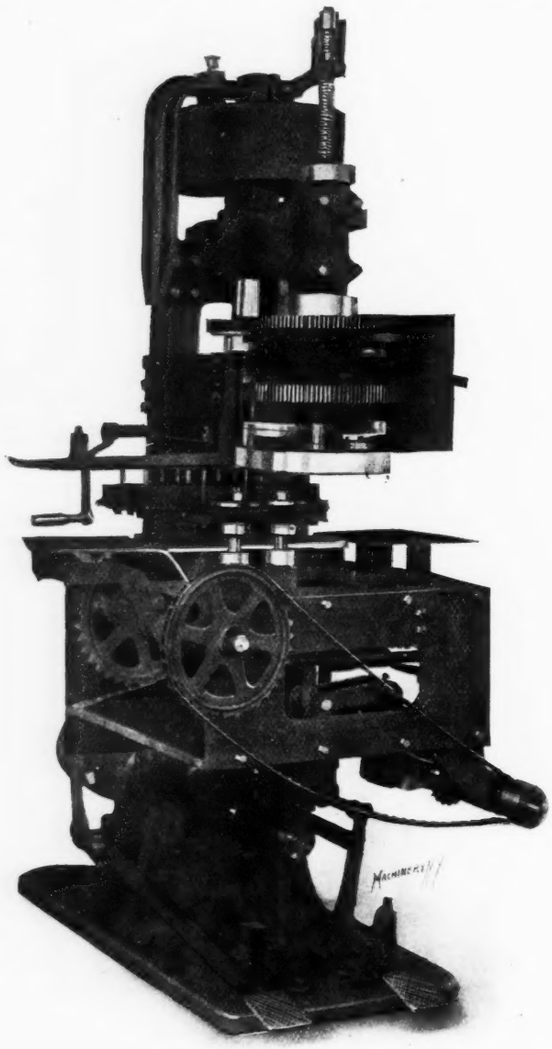


Fig. 11. Automatic Double Seamer for Condensed Milk Cans or Food Products

a marble statue or in an opera. This artistic instinct gives some difficulty to the man who lays out the rolls for forming the seam; but the job can be done to the queen's taste nevertheless, with care and experience on the part of the designer.

* * *

In the manufacture of the best grades of leather belting, a comparatively small section of a hide is used, this being a strip about 30 inches wide extending from the tail to a point just back of the shoulder, its length being about four feet. On account of the ignorance of most users of belting, and the difficulty of telling the grade of a belt except by use, certain leather belt makers are not over scrupulous as to the grades of leather entering their product, and we find not only is the section mentioned used, but flanks and other undesirable parts which are doubled with first grades in double belting. A belt made up in this manner may not in appearance be inferior to a belt made only from first-class parts, but in use it is bound to give inferior service. The use of the poorer grades with the best grades of leather belting is particularly bad. The inferior grades soon stretch, throwing almost the entire stress of belt pull on the superior grade. The result of this uneven tension is to quickly deteriorate the belt. Probably a belt made up in this manner is inferior to that made of the poorer grades throughout. Making the belt of inferior grades throughout has the merit of equalizing the stretch, keeping both parts in even tension.

A NIGHT-SCHOOL COURSE IN BLUE-PRINT READING

GEORGE A. HEPKE*

From time to time there have appeared in technical magazines and journals articles pertaining to courses as taught in night schools, in which the best way to present such courses in order to get the desired results, was discussed. I have followed these articles rather closely, but I do not remember having seen one in which the method of teaching blue-print reading is treated. No doubt, many of MACHINERY's readers will be interested in the plan I followed in teaching the subject to a night-school class composed of pupils who were working in the different manufacturing establishments and who were handicapped by not being able to read blue-prints.

The idea was to cover about the same ground as a course in mechanical drawing, but in a much shorter period of time. The pupils desired to be able to read a blue-print correctly, but they did not want to spend the time necessary to become proficient in drawing. Nevertheless, they were desirous of understanding how projections, etc., are derived. At first a temporary schedule of instruction was arranged, but this had to be departed from during the course in order to meet the conditions. The course, as originally planned, was to include twelve lessons, one each week of 1½ hour duration. On the opening night there were ten pupils in the class-room, who ranged in age from 20 to 35 years. They were all followers of mechanical trades in local manufacturing establishments, working as molders, machinists, pattern-makers and core-makers. It was evident after questioning the pupils that it would be necessary to start with elementary work. They understood an object in the plan view, but as soon as it was turned and another view projected, they were at a total loss as to what the different lines then represented. In order to present this subject of projection as clearly as possible, wooden blocks were made as shown in the different illustrations, the construction of which will be explained in the descriptions of the lessons. These blocks, together with blackboard illustrated lectures, aided greatly in making things appear simple and clear.

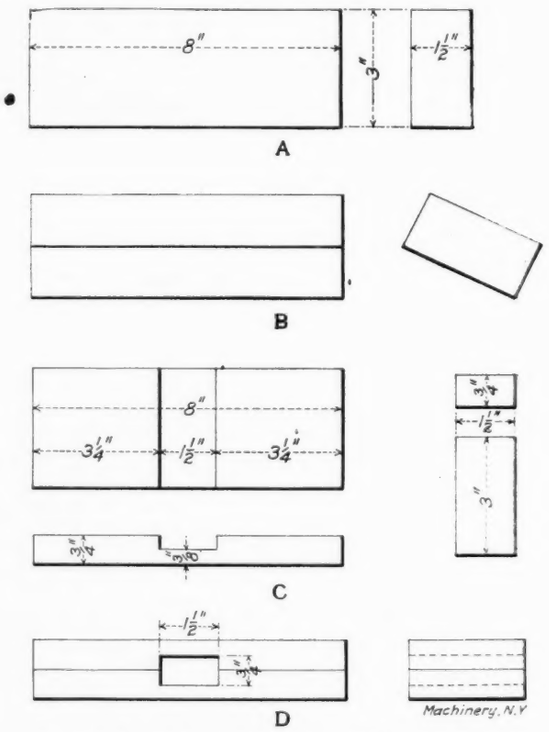


Fig. 1. Built-up Rectangular Prism used in teaching Projection

In the beginning, the difference between perspective and mechanical drawing, and why the former cannot be used extensively in mechanical lines, was explained. In begin-

* Address: 210 Chestnut St., Hamilton, Ohio.

ning the instruction in projection, a drawing of an assembled rectangular prism (built up of three parts) showing all the full lines but no dotted lines whatever, was made as shown at *A*, Fig. 1. As no dotted lines were shown, the prism appeared as though it were made of one piece, but in reality

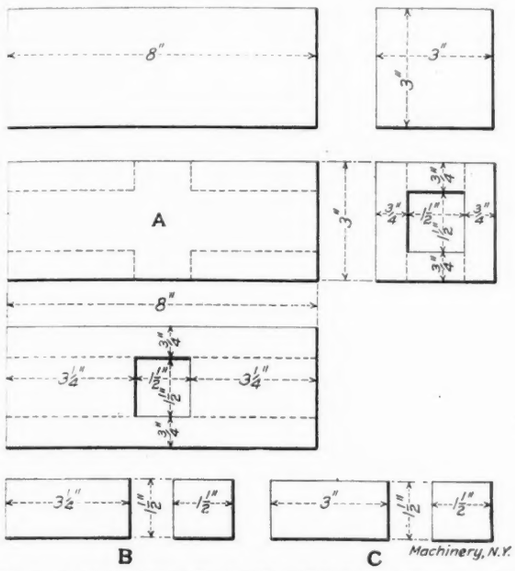


Fig. 2. Another Built-up Block with which Various Forms can be obtained for teaching Projection

it was composed of the three pieces. This prism was next projected as shown at *B*, after which it was taken apart and the pieces which formed it, projected as shown at *C*. This was done to illustrate how the channel through the center would be indicated on a drawing. Two of the three parts which form the prism were then placed together, as shown at *D*, which made it appear like a solid block with a hole cut through it. This hole gave dotted lines in the end view as shown. To illustrate the need of dotted lines, I used clear

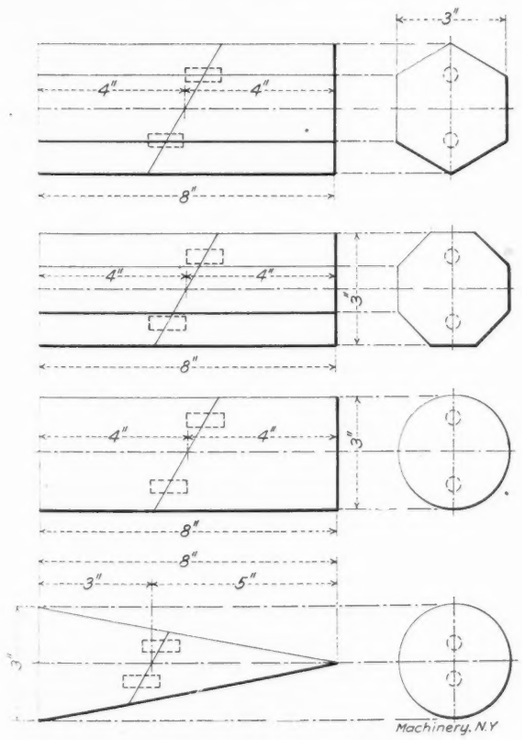


Fig. 3. Prisms, Cylinder and Cone, which were also used in teaching Projection

glass as an example, and the pupils were told that if the piece as assembled were made of glass, the lines representing the hole cut through the prism would appear full, but as the piece was made of a non-transparent substance, dotted lines were used to represent lines that did not appear to the eye.

The square prism shown in Fig. 2 was the next object used, and about the same instruction was given as with the rectangular block. This prism was composed of one piece *A*, two pieces *B*, and one piece *C*. When these pieces were put together we had a solid square prism and by taking them out, projections in which dotted lines appeared were obtained. The next objects drawn were the hexagonal and octagonal prisms, after which cylinders and cones followed in the order mentioned. With the different prisms made as shown, we were able to get quite a number of combinations and projections.

At first, only projections of the complete solid bodies were taken as shown in Fig. 3. The blocks which were held together by dowels, were then taken apart so that the projecting of angular surfaces could be practiced. As shown in Fig. 4, all the lines were designated by letters, so that the corresponding lines in different views could be easily located. These letters were found to be a great aid. The idea in giving the pupils the angular projections was to fit them so that when they encountered round bosses or pads of other shapes shown at an angle on a drawing, they would readily see how the projections in the plan or other views were derived.

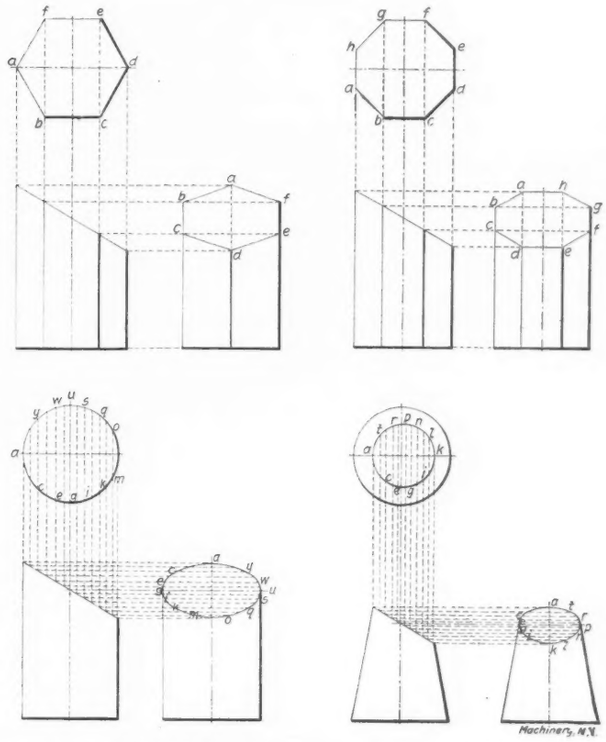


Fig. 4. The Blocks shown in Fig. 3 taken apart and used to teach the Projection of Angular Surfaces

Five lessons were devoted to the routine just mentioned and projections were covered quite thoroughly, but this work had to be supplemented by practice still to follow. It was during these five lessons that I discovered that the pupils had the most difficulty in learning in what direction the object was turned or set up to get a given view. The wooden blocks proved very effective in overcoming this difficulty, as they could be turned in whatever direction was necessary so as to correspond with the different views on the blackboard. During the five lessons mentioned the pupils were given the task of making drawings on the board of the different blocks, after a cut-out or something of that sort had been indicated upon the blocks with chalk. They did fairly well with this work, which enabled the judging of their progress, and also whether or not they understood projections.

The next step was to acquaint them with sections and sectioning. Different sections of simple objects, such as the blocks, for example, were drawn, and instructions given in following up a drawing in order to tell at just what point the section was taken when this was not indicated by letters. The type of sectioning for the different metals was also brought up, because in a great many assembly drawings

the kind of metal is not specified, the type of sectioning taking care of that.*

Taps and threads were next discussed, and the different ways of showing threads was explained. Thread pitch and lead were also brought up, and it was explained that where the number of threads and pitch are not given, it could be taken for granted that it was a United States standard thread or whatever standard the firm recognized. In brief, all of the kinks and short cuts that are in general use were explained, such as showing shafts, etc., broken, driving fits, and the method of designating bearings on shafts, with cross lines. The object in explaining all these points was to familiarize the pupils with such things, as I have discovered that the majority of mechanics have not the least idea what these short cuts and kinks represent and are often confused by them.

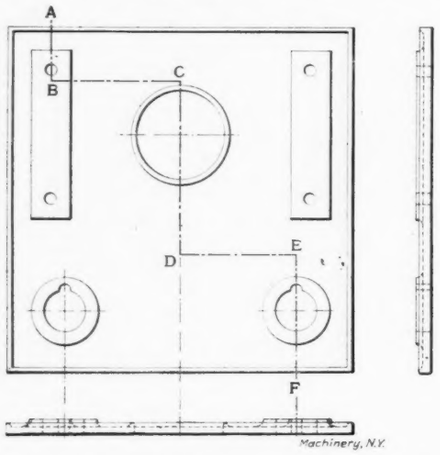


Fig. 5. Type of Drawing used for the Elementary Exercises in Blue-print Reading

The next subject treated was gearing. The different kinds of gears were described and the meaning of pitch diameter, outside diameter, pitch angle, turning angle, cutting angle, and the words addendum and dedendum, were thoroughly explained. We then took up the drilling and tapping of flanges, and all the terms of abbreviations generally used for this work, such as B. C. for bolt circle, D. C. for diameter circle, 2 Up for staggering center line, 1 Up for on center line were given. After that the method of indicating center lines and dimension lines was explained, and also that the arrows at the intersecting lines show that the piece is of the shape given on the drawing for the length between the arrows. Scaling of drawings was also treated, and the method of getting the approximate dimensions of a piece with an ordinary 2-foot rule when the dimensions are not given, and the drawing is made to scale, was explained.

Up to this point a blue-print had not been touched, for my object was to so acquaint the pupils with the various points mentioned that they would make rapid progress when the blue-print reading began. The first blue-print used was that of an engine cylinder sole-plate, as shown in Fig. 5. This simple drawing puzzled the pupils a little because of questions asked them, all the points of the preceding lessons serving as a basis for the questions. Other blue-prints of sole-plates of different types were thoroughly covered by taking sections at different points and showing these on the blackboard. As the students wanted to do a little work at home, I had them draw a section of the sole-plate through *A*, *B*, *C*, *D*, *E*, *F*. They did this work very well though they were somewhat confused at first.

The next lesson consisted of engine disk cranks, a governor gear-box, and other prints which were a little more difficult than those of the preceding lesson. The same tactics were followed with these prints, and the pupils were also given more home work, with the result that a decided improvement was soon noticed in their sketches. More and more difficult prints were used as the course continued, with the result that at the end of the twelve lessons, the students had a very good idea how to read a blue-print correctly, but the thing still needed was practice in order to develop this knowledge.

They were now greatly interested and demanded that the course be continued for twelve more lessons, which was granted. We resumed our studies where we had left off, always taking up something more difficult. Some of the lessons consisted of drawings of large pieces, such as engine beds and cylinders, fly-wheels and other large castings. Another line of blue-prints used were those of a 300-ton hydrostatic wheel-press. All the different parts of this press were located in the assembly drawing from the details, and the work was conducted the same as if the class were machining and erecting the complete machine. The pupils were also required to draw sections of the various parts, such as the one illustrated in Fig. 6. After finishing with the press prints, assemblies were dealt with, some of which were rather complicated drawings, until the end of the term.

I do not claim that any of the pupils were experts at the end of the course, but I think that they had a good foundation for development. Had the pupils been familiar with projections we could have covered the same course of study in a much shorter period, and also would have gained considerably more ground. Nevertheless, I am perfectly satisfied with the results when the conditions under which we started are taken into consideration. The course as outlined in the foregoing would probably not work so well in another case, as everything depends upon the men and the conditions, but it will doubtless have suggestive value.

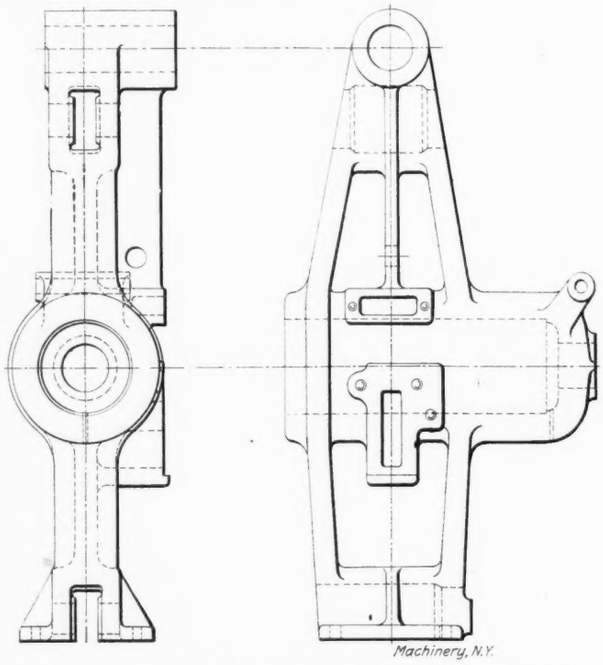


Fig. 6. Detail Drawing used in connection with more Advanced Work

* * *

Referring to the item published in the July number of MACHINERY on the use of "victimized power" in operating penny-in-the-slot machines, in which it was made apparent that the action of the operator was a necessary element in the success of such machines, attention is called to an article in the July 3 number of the *Saturday Evening Post* by Mr. Frederick Thompson, in which he points out that this is a prime factor in the success of all amusement enterprises. Those enterprises are most popular in which the people amuse themselves, the apparatus, game or device being such that the chief factors in the sport are the people taking part. The tickler, witching waves, shoot the chutes, and other devices that have proven enormously popular afford as much or more amusement to the onlookers as to those who participate in the games.

* The practice of indicating the character of materials by cross-sectioning should be abolished. There are no generally accepted forms of cross-sectioning for the common materials even, and as for the less common materials, almost every draftsman feels free to use the form that appeals most to his fancy. In all cases the material should be plainly specified by name.—EDITOR.

ELEMENTS OF ASSEMBLING OPERATIONS*

ALFRED SPANGENBERG†

The machine shop operations usually discussed by various writers have been almost entirely associated with machine work. Aside from this, and a factor of equal importance, is the subject of assembling. In its broadest sense, assembling may be defined as the operation of combining and adjusting the separate parts of each unit in such a manner that these units, when in combination, will properly perform a predetermined function. The operation of fitting is often included in the work of assembling; under ideal conditions, however, a distinct line of demarcation can be drawn, so that the term "fitting" will only apply to the operation of machining.

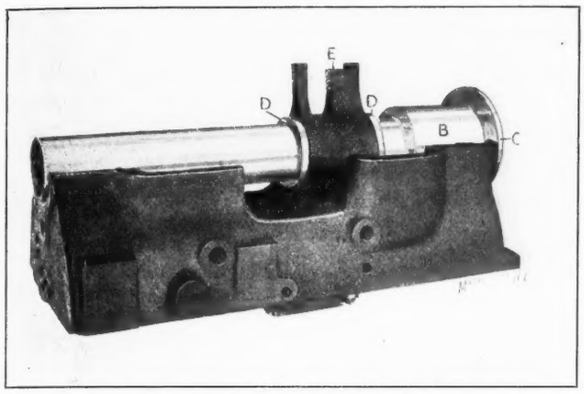


Fig. 1. Method of Gaging Clearances for Spindle Gears in a Lathe Headstock

The purpose of this article is to show the possibilities that lie in developing methods of assembling that will ensure accuracy, economy and standardization, but before giving any concrete examples, it will be well to consider briefly the elements that directly affect the cost of assembling operations. The determination of proper methods and processes of assembling are peculiarly difficult, since the elements of human judgment and skill enter so largely into this work. It is a far more puzzling proposition than that of analyzing and determining the best method for machining any particular part. For this reason, the study of assembling work requires particular care and especially keen analysis.

The Three Factors Leading to Economical Assembling

Accurate drawings, accurate machine work and the use of jigs and gages, are at the foundation of economical assembling. Without these factors, the term "manufacturing," used in its limited sense, really does not apply to the scheme of production. Much has been written on methods of dimensioning drawings and the use of limits as tending to accurate and at the same time cheap production, so that little need be said here on the subject. The system of giving all unimportant dimensions in inches and common fractions thereof, and expressing precise dimensions in thousandths of an inch with the permissible limit of variation, is worthy of wider application. This, coupled with a thorough system of inspection, will insure that the parts function properly when assembled, besides preventing a choice of methods in machining that may entail a vast amount of work when less elaborate methods will produce a job that is good enough for the purpose. While the use of limits on drawings has been unsuccessful in many cases, the principal cause of its failure probably has been due to an injudicious selection of the maxima and minima for different classes of work.

In order to insure the accuracy of the machine work, it is absolutely necessary to provide for a thorough system of inspection in the machine departments. Some manufacturers only provide for inspection of the finished product and refuse to admit the advisability of adopting the broader plan. To state an important point which the author shall want to emphasize, we must always keep in mind not only the possibility of wasted money through excessive time in having to "fit" the parts in the assembling department due to poor machining, but *especially* the waste of valuable time in having to wait for parts to be replaced that have been spoiled in machining, the error not being discovered until ready for use. In brief, it is short-sighted to imagine for one moment that anything like economical results will be obtained in assembling unless this provision is made.

The great value of, and necessity for, jigs and fixtures on duplicate work and their bearing on the cost of assembling is too well recognized to need any further comment here.

Method of Investigation and Analysis

First of all, a careful analysis of the assembly drawings should be made in order to thoroughly understand the purpose of every part of a machine. This is an important consideration and will lead to the adoption of methods that will prevent undue accuracy and unnecessary expense consequent thereto. It is a mistake to accurately align and fit parts that may be said to "fit a hole in the air." The time needed for this can be more profitably spent on those parts that require accuracy and refinement. The purpose of every part should be studied; the operation necessary to produce it can then be regulated accordingly.

A matter that should receive careful attention is the question of rigidity in fits. Those of us who have "been through the mill" are painfully aware of the fact that most workmen fail to distinguish the difference in rigidity required in the fit of a lathe spindle from that necessary in the case of a shaft for operating a clutch lever. An illustration in support of this statement is afforded in the case of an automatic machine that recently came under the writer's observation. The machine in question was built by a manufacturer having a reputation for turning out very accurate work; in fact, the fits were so tight that at times certain members of the feed-stop mechanism would fail to function properly with the result that a part of the machine would be wrecked. After these members were fitted free enough, no further trouble was experienced.

Varying conditions make the determination of proper fits and adjustments in assembling work a question of experience and judgment. As a general proposition, sliding or revolving machine elements that do not affect the accuracy of the machine's product should be fitted perfectly free, so that there will be no indication of the parts working stiff. This applies especially to spring- or hand-operated mechanisms. Sometimes,

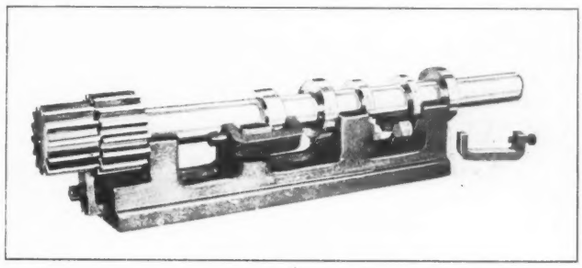


Fig. 2. Jig for Drilling Pin-holes in Collars on their Shaft, to insure Interchangeability

however, the fact that these elements are apparently fitted or adjusted too tight can be attributed to their being out of proper alignment.

The next logical step in the study of the drawings will be to map out systematic and well-defined methods and processes of assembling so that the parts may be quickly and cheaply assembled, all will be in their proper relation to each other, and that the alignment of the various parts will be perfect within the required limits. Various ways of accomplishing the object sought will present themselves successively; unless special considerations prevent it, the process that will accomplish the object sought in the most direct manner is the one to be chosen. This consideration shows the importance of a thorough knowledge of modern methods, the facilities at command, the organization itself, and special tools and appliances.

General Requirements for Efficient Work

The drawings must always be followed. No deviations should be permitted. If any mistake is discovered or change found necessary in the interest of economical assembling, then

* For additional information on this subject, see MACHINERY for February, 1909, "Application of Lifting Devices to Assembling Work," and April, 1909, "Labor-Saving Devices for Scraping Operations."

† Address: 951 W. 5th St., Plainfield, N. J.

these corrections should be approved by responsible parties and made on the drawings. The importance of this is at once apparent. Standardization without observing this rule is impossible, and neglect of it will result in lax, inaccurate, and totally misleading methods of production. Again, in case of repairs, the new parts can be finished to the drawings with the assurance that they will fit properly. The drawings should always indicate the method of oiling a mechanism, as this matter, if left to the judgment of the assembler, may result in an inefficient system of lubrication.

If any errors are found to exist as a result of mistake in patterns or fault in casting, then these mistakes should be taken care of at once, so as to prevent a repetition on succeeding pieces. In the case of clearances this will prevent unnecessary "carving" to be done either by chipping or machining. In many instances, however, when the clearance allowed on rough castings is small and the design will not permit a change, it is unreasonable to expect avoidance of "carving."

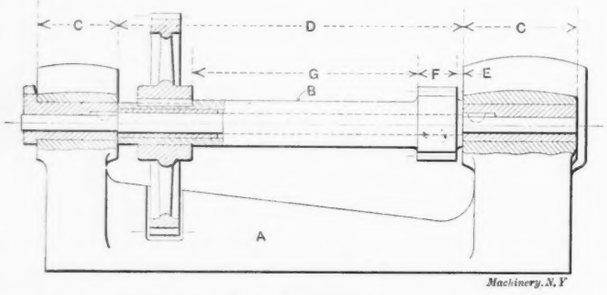


Fig. 3. Illustrating a Case where the Micrometer can be used advantageously for Length Measurements

Such cases should be anticipated before any assembling operations are commenced, and the necessary clearance made by chipping or machining so as to prevent having to take the work apart.

This principle is clearly illustrated in Fig. 1, which shows a lathe head-stock. For special reasons the clearance allowed in the head-stock casting for certain gears that run on its main spindle is very small. The gage for testing this clearance consists of a hollow arbor *B* having a locating flange *C*. Mounted on this arbor and free to turn between the collars *D* is the gage casting *E*, which has a contour 1/16 of an inch larger than that of the gears above referred to. By turning the gage it is very quickly determined whether there are any irregularities on the head-stock casting to be chipped off. The

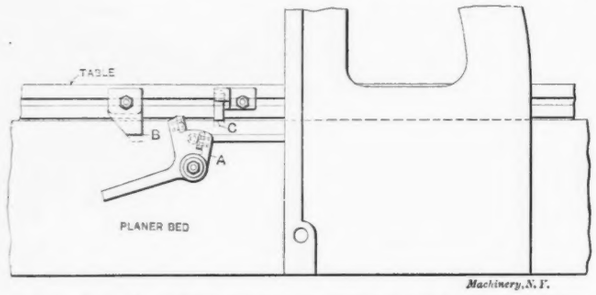


Fig. 4. Example of Work where some Fitting is left for the Assembler

advantages of using this gage are that the irregularities can be more easily seen than by using the gears and spindle; any necessary chipping is done before the assembling operations are commenced; and the gage, being light, is quickly and easily handled.

Much profitable study can be given the question of substituting the machining process for operations that are usually performed by hand, such as chipping, filing, etc. Oil grooves should be machine cut on all pieces that can conveniently be handled on a machine; tap holes can be tapped cheaper on a machine than by hand, except in the case of very small holes in large pieces; set-screw holes in shafts should be drilled on a drill press. The halftone, Fig. 2, illustrates the method of locating and drilling collars on a shaft in interchangeable work.

One example will suffice to show the possibilities of saving time in this direction. For many years it had been the practice of a certain machine tool builder to chamfer the threads on all split-feed screw nuts by chipping and filing. It will be understood that this is necessary in the case of split nuts so as to permit their opening and closing on the feed screw, the chamfer being at the joint. On a certain size nut it formerly took twenty minutes per pair by the hand method. The same size is now milled, using two cutters simultaneously, in one minute per pair, which includes clamping and removing the work.

It is, of course, unreasonable to expect to entirely do away with these hand operations, but in many instances to-day much of the chipping, filing and scraping could be avoided if proper attention was given to the matter. Probably the most notable example of the tendency in this direction is afforded in the manufacture of automobiles, where the hand operations consist merely in combining and adjusting the various elements.

Standardization

Standardization, as already pointed out and emphasized, is one of the "secrets" of economical assembling. It is a matter of common knowledge that interchangeable manufacturing is really economical manufacturing, and yet in many instances its fullest possibilities are not realized. There are many shops to-day that still cling to the old custom of "making every piece like itself." The practices of leaving stock for adjustment on the hubs of bevel gears, facing off the ends of bearings to no particular dimension, planing taper packings to fit slides that are not planed to gage and adjusting parts to fit others that are not standard, must be eliminated if economical results are expected. Some very simple form of gage, such as an inside or outside micrometer, will enable work of this character to be machined standard and made practically interchangeable at a fraction of the cost in assembling.

An example is given in Fig. 3 to illustrate this point; *A* represents an engine lathe head-stock having a back-gear quill *B* running between the eccentric-shaft bearings as shown. The length *C* of the bearings and the eccentric bushings can be made to an outside micrometer, while an inside micrometer is used to measure the length *D* between the bearings, the proper allowance being made on the quill for a running fit. An ordinary scale is used to take the measurements *E*, *F* and *G*, and, if care is exercised, the gear and pinion on the quill will line up with those on the main spindle, if the same precautions are taken in the case of the spindle shoulders and gears.

The experienced man will smile at the idea of these quills having to be adjusted by the assembler, but the author recently visited a shop building small engine lathes where this practice was still in vogue.

Errors in measurements of length are far more likely to occur and cause trouble in assembling than errors in diameter. This is probably due to the fact that in the latter case instruments of precision, such as the micrometer or limit gage, are in more common use. Standard length gages are indispensable on interchangeable work, although in instances similar to that referred to in Fig. 3 scale measurements are accurate enough. The fact is that few workmen can, or really do, work nearer than 1/32 inch with a scale.

However, there are cases met with in assembling where it is not practicable to machine all the parts standard, owing to the fact that a number of conflicting elements enter into the problem, and make it advisable to leave stock for adjustment on certain pieces. A concrete example is afforded in the case of a planer reversing mechanism, which is illustrated in Fig. 4. It is obvious that the rocker *A* must swing through a certain definite arc, the amplitude being limited by the movement of the belt shifter cam (not shown) and controlled by the lengths of the dogs *B* and *C*. It is at once apparent that there are a number of measurements which must be considered; a discrepancy in any one of them would make a difference in the working of the mechanism, and the easiest and quickest way to fit the dogs is to swing the rocker in one extreme position and scribe a line on the corresponding dog representing the cam face on the rocker; then repeating the operation in the other extreme position of the rocker. The dogs are then taken off and sawed close to the line, after which the surfaces are smoothed with a file and the steel members removed for the purpose of hardening.

Duplication

The duplication of parts in quantities is another step in economical manufacturing. For special reasons it may not be advisable to build the complete machine for stock, but in nearly every instance the standard parts can be assembled in lots and kept in stock ready to be placed on the bed of the machine when ordered. The advantages are many. First, a large reduction in initial cost results because of this production in quantities. This is due to the fact that the same operations can be performed on a number of pieces in succession. Again, the possibility of always having these parts on hand when wanted means quicker deliveries.

Methods and Processes of Assembling

The methods and processes of assembling will, of course, vary with the character of the work and the design of the machine, so that it is impossible to outline any comprehensive system with the tnought that it could successfully be applied

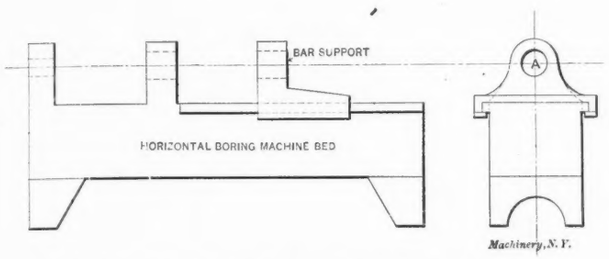


Fig. 5. A Case where some Machine Work is done after the Work is partly assembled

to all conditions alike. Indeed, a blind adherence to certain rules is liable to be a serious detriment. It is possible, however, to lay down a few fundamental principles which can safely be followed and which are adaptable to many differing conditions.

As was previously stated, the design and construction of a machine are intimately correlated, as becomes apparent when special methods needed for its construction have not been taken into account. For this reason, the designer should continually be impressed with the importance of bringing out the best possibilities of manufacture, both as to ease and cheapness of assembling, as well as machining. The tendency of modern machine design is toward the unit system of construction in which the various units comprising the driving members, feed members, etc., are self-contained, being placed in gear-boxes and bolted to the bed of the machine. This feature enables the various units to be assembled independently and simultaneously, and is an important consideration, since the shortest possible time in which any particular machine can be assembled depends upon the number of operations that can be carried on at the same time. The most notable examples of the unit system of design are afforded in modern drilling and milling machines.

On the other hand, when the design is such that the parts are more or less interdependent, it is possible to separate or classify into groups the various members so that the unit system of assembling can be followed to a certain extent. This is especially true of interchangeable manufacturing where the necessity of adjustment is eliminated.

This important feature should be emphasized that, in assembling work, it is highly advisable to provide for the same rigid sub-division of labor that exists in the modern machine department. Thus, the operations involved in assembling the units should be separated from the erecting process on the beds. In large shops these processes are carried on in different departments.

The operations involved in assembling, such as chipping, filing, scraping and fitting, are usually performed either at the vise and bench or on the floor, depending on the size or weight of the work; hence the name vise, bench and floor work.

Bench work is of a lighter nature than floor work, though it may, and often does, include the entire assembling process when the detail is small, and in case of large work many of the smaller parts are assembled at the bench and are then taken to the floor and adjusted to the other parts.

Floor work includes the erecting and assembling of heavy machines, and the machining of parts too heavy or too large to be operated on in the stationary machine tools.

In general, the sequence of operations is somewhat as follows: Work coming into the assembling department from the various sources should have all the machining operations completed, the only exceptions being in cases where it is absolutely necessary to leave stock for adjustment and where, owing to the fact that some parts are interdependent, it is not possible to carry on all the operations of machining at one time. A concrete example illustrating the latter case is shown in Fig. 5. It is obvious that it would not be practicable to bore the shaft hole *A* until the scraping operation is completed on the bed and carriage. In this particular case the support is bored in place on the bed.

The preliminary assembling operations of such parts as are interdependent consist of the chipping, scraping and aligning operations. Should chipping be necessary on parts that require scraping, then the chipping must be performed first in order to avoid having to take the work apart and to prevent the possibility of springing the pieces. Next in order are the scraping operations on such members as slides, carriages, ways on beds, spindle bearings, etc. This is to facilitate the lining up operations. On small work, the use of special surface plates enables the pieces to be scraped and made practically interchangeable without having to try the pieces together, while on large work the element of spring in large surface plates, besides other considerations, precludes their use. Special lifting and pulling devices such as those described in the writer's articles in the February and April issues of MACHINERY will greatly facilitate the work of scraping.

The determination of methods for quickly and easily lining up the various brackets, shafts, etc., is a matter that should receive careful thought. Whether or not jigs and fixtures are used will determine to a large extent the processes employed, although the final alignment of the brackets and bearings before the dowel pin holes are reamed, will be much the same in either case, the use of jigs saving the laying out of the screw holes. The halftone, Fig. 6, illustrates this principle and shows the method of aligning the brackets and feed-box on the head end of a turret lathe bed. Separate jigs are

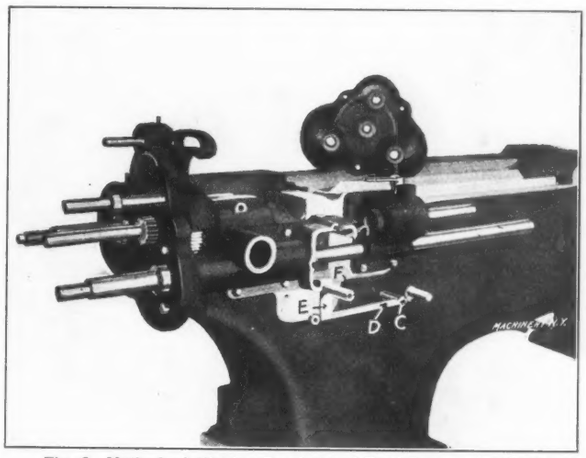


Fig. 6. Method of Aligning Bracket and Feed Box on the Head End of a Turret Lathe

used for each member in drilling the clearance and tap holes and in boring the shaft bearing holes. To align the bracket members on the bed for the purpose of drilling and reaming the dowel pin holes, special arbors are used to bring the shaft bearings in the brackets and gear-box in line with corresponding bearings in the bed. With the clamping screws only tigntened sufficiently to hold the various members in place, the brackets are shifted slightly to permit the arbors to be turned freely by hand, which indicates that all the bearings are in proper alignment. The clamping screws are then tightened down, and the pinning operations completed. It should be explained that the gear-box cover is in place on its base during these operations; in Fig. 6 it is shown on top of the bed for the purpose of showing the arbors more clearly.

If jigs were not used, as explained above, the brackets and gear-box would have to be lined up and held by clamps for

the purpose of marking off the screw holes in the bed. Incidentally, the method of setting the stud *C* with reference to its slot for the connection *D* is shown. The sheet-iron gage *E* supports and locates the connection from the stud *F*.

In cases similar to that in Fig. 6 where it would be necessary to remove the shafts and gears in order to line up the brackets, it is advisable to perform this operation first. Otherwise, the units can be assembled complete, and then lined up on the bed.

The operation of assembling the individual units merely involves the chipping of oil grooves, hand reaming, fitting of keys, etc., and combining the various elements. Whether the units are sent to the storeroom or directly to the erectors, all operations of fitting and adjusting should be completed as far as possible. This will prevent the erectors from losing time by having to run to the vise and bench to fit the parts. Thus, in the manufacture of lathes, the head-stocks, tail-stocks, rests, aprons, etc., are assembled as complete units and are then sent to the erector to be fitted onto the lathe bed.

All work on the beds and such as cannot be performed when the units are fitted, is, of course, done by erectors. This includes the scraping of the larger pieces, the lining up operations as already explained and the final adjustments and testing of the complete machine.

The principal point to be observed on erecting work is to plan the method of combining and adjusting the various units on the bed of the machine so as to avoid having to take the work apart, due to neglect of some vital point. The practice of taking the work apart unnecessarily shows lack of forethought in planning the methods and processes of assembling and emphasizes the principle already outlined of mapping out the sequence of operations before hand.

A very careful consideration of all these problems and a serious attempt to solve them scientifically will bring surprising results. It hardly seems necessary to argue in favor of the adoption of the methods and processes advocated, since the experienced man will at once recognize them as being the most natural to follow. Yet the lack of effort to accomplish these results in most well-run shops (to say nothing of the poorly managed) is as singular as it is prevalent. In place of haphazard, inefficient methods must be substituted those that will lead to the adoption of standards proven by experiments and experience to be efficient, and these must be adhered to without deviation.

* * *

A German professor in a lecture on the chemical relations of aerial navigation pronounces helium to be the ideal gas for lighter-than-air airships. The professor points out that the gas is uninflammable and that it can stand a cold of —268.5 degrees C. without liquefaction. The first quality would, of course, be valuable, but as regards the second quality, its value is doubtful, as aerial navigation is not likely to put such a test on the gas used, and it would be interesting to know where the professor expects that the airships would be subjected to such a temperature, and also how he would expect the navigators to survive. Besides, the professor ought to have pointed out how to get the helium. The small quantity of one hundred gallons possessed by the Leyden University is not intended for public consumption. The professor, therefore, realizing the impracticability of helium, cheerfully advises the making of experiments with superheated steam!

* * *

The first steel plant south of Mexico is being built at Corral, Chile, and is expected to be ready for operation early in 1910. The daily capacity will be 200 tons. The machinery for this steel plant is principally of French manufacture. A fine quality of iron ore is found in large quantities within five miles of the plant, and for fuel will be used charcoal produced from the extensive forests in the vicinity; it is proposed to produce iron and steel of the highest quality. It is expected that the opening of the steel plant will encourage the development of many other industries that are dependent upon the iron and steel industries for raw materials. This will open a market for industrial machinery, and American manufacturers should keep in close touch with Chilian development for the next few years. Machinery enters the country free of duty.

THE MANUFACTURE OF GAGES*

T-Square

The introduction of our present gage system was made necessary by the development of our modern methods in the manufacture of interchangeable parts; a complete system of gages is absolutely essential to the accurate and economical production of interchangeable parts in large quantities. Some manufacturers have been slow to recognize the necessity of absolute interchangeability in their products. This has been particularly true of some machine tool makers; who

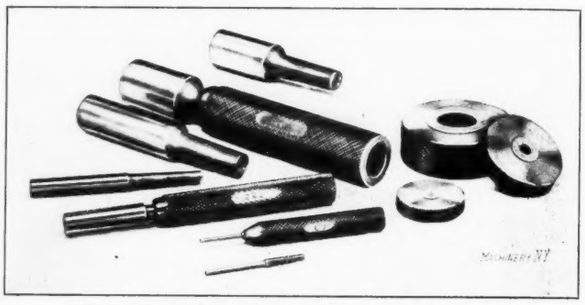


Fig. 1. Plug and Ring Gages of Approved Construction

has not seen half a dozen lathes of one make and pattern in the same shop where not even chucks were interchangeable?

Probably no class of manufacturers has more fully realized the necessity of absolute interchangeability than the makers of small firearms, and to gun makers is due much of the credit for the development of gaging systems and the training of highly efficient gage-makers. The standard methods adopted by them can, with slight modifications, be adjusted to fill the requirements of any manufacture; but the slow adoption of gaging systems is largely due to the manufacturer's prejudice which is often strengthened by ignorant or incompetent foremen who decry anything that savors of improvement, impelled by motives of fear that any innovation might carry beyond the narrow groove of their capabilities.

Principles of Development of a Gaging System

The manufacturer who contemplates the establishment of a gaging system must use the greatest care in the selection of his designer, for the question of economy hinges on the experience, foresight and ingenuity of the latter. The designer should be a man familiar with shop methods, and must be on good terms with the men with whom he must

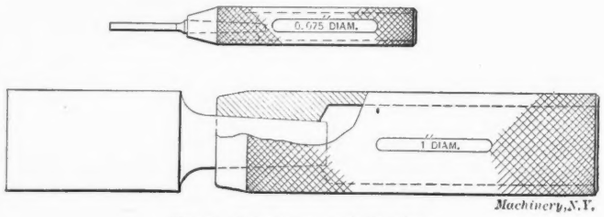


Fig. 2. Plug Gages and Handles

cooperate. In this way he will be able to gather considerable information which will be of great assistance to him in the production of efficient results.

The designer must satisfy himself that each piece being machined is handled to the best advantage, and that each cut or operation is in proper sequence. Having done this he can then lay out his gages in such a manner that each operation will have its own equipment, independent of other operations, thus insuring uninterrupted progress of the work.

In machining parts intended to be interchangeable it is necessary first to establish certain working points which are maintained throughout the entire series of operations. In some cases the working point must be shifted during the progress of the work, through the creation of a more important point after the taking of some cut, or the necessity of cutting away the original point. Very often two holes (not always neces-

* For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: A Few Suggestions in Tool-Making, May, 1904; Lapping Flat Work and Gage Jaws, November, 1907; Making Thread Gages, February, 1908.

sary to the completion of the work), drilled and reamed in the piece, are used for locating it on pins inserted in the various jigs and fixtures, thus bringing each piece in like relation to the cutting tool after the proper setting has been established. And, again, it is sometimes found expedient to use one hole, and one surface, or one end and one side as holding points, and the designer must ever bear in mind that he must gage from the same point from which the piece is located or held, whenever it is possible to do so, although, of course, there are exceptions to this rule.

Should the parts on completion of the machining operations be required to pass through a system of inspection, before being assembled as a whole, which is the custom in some lines of manufacture, the gage designer is confronted by an entirely different set of conditions. He has then to do with the finished piece, and does not consider the intermediate stages. He should study the mechanism of the assembled machine, and must understand the function of each piece, and the relation it bears to all other parts; then will he first be

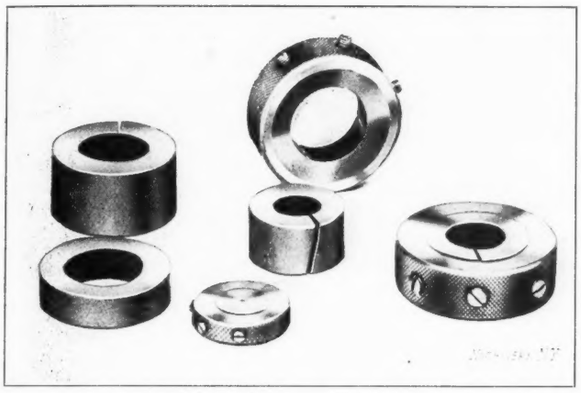


Fig. 3. Lap and Lap-holders used for Making Plug Gages

able to produce gages which will correctly test the vital points, with accurately established limits of tolerance.

The next essential to the economical inspection of parts is to limit the number of gages to as few as possible; when considering that parts are often made in lots of from 5,000 to 50,000, and each piece is to be inspected, the importance of this will be readily understood. It is *common* practice to combine gages of the simpler forms, such as a series of snap gages, or snap and profile gages, on the same plate; or a number of ring gages inserted in a plate also bearing snap or even profile gages. It is not, however, *good* practice to combine profile gages with any other type, as their longevity is much greater than that of any other form.

It is on the manufacture of the simple, but much used plug and ring gages we shall treat in this article, not with the old time machine shop conception of a gage, as something unquestioned (but often questionable) as to accuracy,

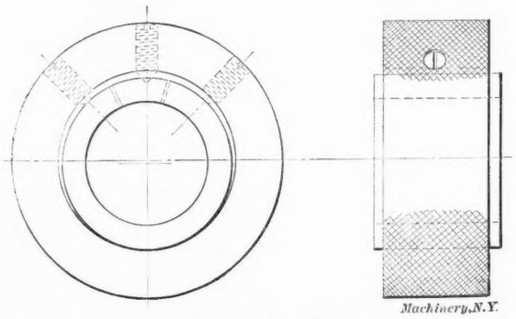


Fig. 4. Design of Lap and Lap-holders for Making Plug Gages

to be locked up in the boss' desk and brought forth only on state occasions, and given out with many solicitations for its care, and its safe return; but as something made in quantities, to be used, worn out and replaced.

The Making of Plug Gages

Our earliest, and in some cases, our latest, recollection of a plug gage is an unwieldy affair, either knurled or fluted on the handle end, and made of solid tool steel throughout, expensive to make and clumsy to handle, requiring much valuable stock in the making, and extreme care in the tempering (although the latter is always commendable as the danger of water cracks is always imminent). However, we now have a much improved design not only convenient to handle and symmetrical in form but comparatively inexpensive to make, and with the risk of loss in hardening reduced

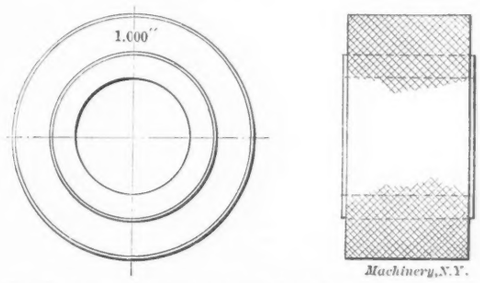


Fig. 5. Approved Construction of Ring Gages with Holders

20 to 50 per cent. This last depends first on the compact design, separate from the handle, and secondly, on the small amount of time expended up to the point of hardening, thus reducing the pecuniary loss when breakage does occur.

Although the designs of these gages, as produced by various makers, differ slightly, the fundamental principle is the same, *i. e.*, to insert the plug proper into a handle from which it can be easily removed, and replaced by another if desirable. The most popular, cheapest and best form, adaptable to plugs from 0.075 inch diameter upwards, is that with the taper shank. These plug blanks are made on a screw machine from drill rod or bar stock, by simply turning the taper shank and cutting off to any desired length, usually ranging from ¾ inch to 2 inches on the straight part. They are then centered for turning, grinding and finishing the straight portion, no further work being necessary on the shank. A number of such gages are shown in Fig. 1.

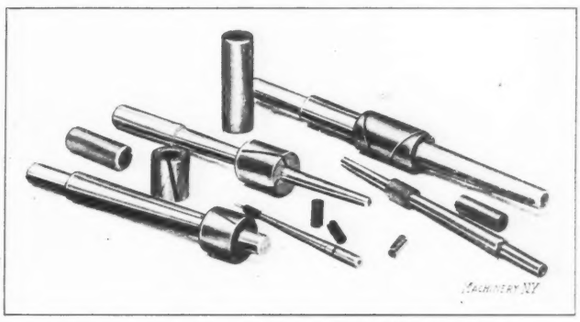


Fig. 6. Lap and Lap Arbors used in making Ring Gages

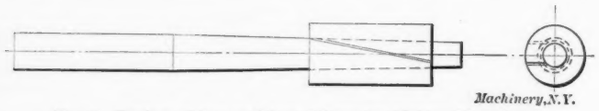
Knurled handles as shown in Fig. 2 are made in standard sizes, each accommodating a certain range of plugs. These handles, being of machine steel, can be turned out very cheaply on a hand or automatic screw machine, when, after stamping size or other desirable marking on spot flatted for that purpose, they can be blued if desired. They are then ready to receive the plug, which is simply driven lightly into the taper end, and when necessary, can be easily driven out from the rear.

Plugs ranging in diameter from 0.075 inch down, should be made from straight hardened wire, which need not be ground, but simply lapped to size, and sweated into the handle, which can be made in the same manner as for the taper shank plugs, but with the front end left solid, and afterwards drilled to suit any desired size. This method of inserting in the handle obviates the necessity of centering, turning or grinding, and the solder will be found sufficiently strong to withstand the torsional strain on a plug of small diameter. As the breakage of these small plugs is quite frequent, this will be found a very cheap and satisfactory means of production. The wire can be bought in a great variety of sizes, and for any given size of plug, wire should be used 0.001 inch larger in diameter, which will be sufficient allowance for the lap to clean up any surface irregularities.

The taper shank plugs ranging in diameter from 0.075 inch upwards, are handled differently. When the blanks are made from bar steel, they should be at least 0.080 inch larger in diameter than the required finished size, as this will insure turning off the decarbonized surface of the bar, and reaching the more uniform structure beneath. In the case of those made from drill rod but half of this amount is necessary. After centering with a small center reamer (large centers should be avoided as they sometimes induce water cracks), the plugs are turned smoothly to within 0.005 inch to 0.010 inch of the finished size, according to length, and carefully hardened.

As plugs require extreme hardness, it is only necessary to reheat them sufficiently to relieve the strain after hardening, excepting those of slender diameter, which should be drawn reasonably low—about spring temper—at the intersection of the shank and body, to prevent them from snapping off while inserted, should any side strain be exerted on the handle. With the use of a little fine emery mixed with sperm or lard oil applied to a simple cast iron or copper lap, pointed similar to a lathe center, and held in the chuck of a hand lathe, the centers are then lapped preparatory to grinding.

The three most desirable results in grinding are straightness, smoothness of surface, and closeness to finished size.



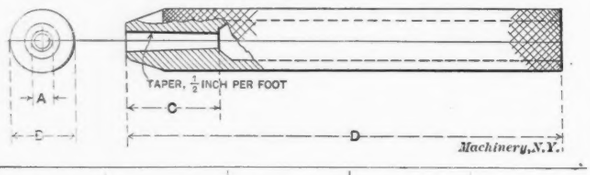
Machinery,N.Y.

Fig. 7. Design of Lap and Lap Arbors for Making Ring Gages

When a good regular grinder is available the best results can be obtained, particularly if it is equipped for wet grinding; for then a piece can be ground to within 0.0002 inch of the final size, with the assurance of a perfectly smooth and even surface. An emery wheel of about No. 80 grade, with the cutting surface reduced to 1/8 or 3/16 inch in width, and kept from glazing or clogging, gives very satisfactory results.

For the benefit of those wishing to do work of this kind, and not having a regular grinding machine at their disposal,

TABLE I. PLUG GAGE HANDLES

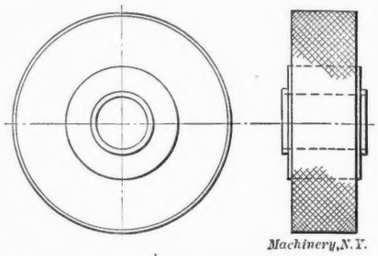


No.	A	B	C	D
	Inch	Inch	Inch	Inch
0	solid	$\frac{5}{16}$	$\frac{1}{2}$	2
1	0.120	$\frac{3}{8}$	$\frac{1}{2}$	$2\frac{3}{4}$
2	0.205	$\frac{7}{16}$	$\frac{3}{4}$	3
3	0.245	$\frac{1}{2}$	1	$3\frac{1}{4}$
4	0.345	$\frac{5}{8}$	1	$3\frac{1}{2}$
5	0.445	$\frac{3}{4}$	1	4
6	0.545	$\frac{7}{8}$	$1\frac{1}{8}$	4

it might be said that usually 0.001 or even 0.0015 inch is not too much allowance for lapping when the work is ground in a bench lathe or other contrivance not made specially for this work. Under such conditions it is difficult to get any but a rough and uneven surface. Before grinding, the piece should be looked over carefully for cracks; those not discernible on the closest scrutiny will make their presence known in the process of grinding or lapping, but at whatever stage they develop, the piece should be immediately scrapped. Should the piece develop a tendency to run eccentric after the surface has been once trued or cleaned up by the grinding wheel, it evidently is cracked.

The object of lapping work after grinding is to give the extreme smoothness necessary to a lasting surface, and the minimizing of friction, and to correct any slight irregularities caused by the grinding wheel or due to imperfections in the grinding machine, as well as to perfect its straightness.

For plug and ring gage work, cast iron makes the best lap, and although it cannot be charged with abrasive as readily as copper or lead, it gives much better results, besides wearing much longer than the other metals. Laps for lapping plugs are made from disks ranging from 3/16 to about ½ inch in thickness, are drilled and reamed to a sliding fit on the ground plug, and split on one side to allow of adjustment, as shown in Figs. 3 and 4. The holders, made in a few standard sizes to accommodate the different disks, are of machine steel, knurled, and having three adjusting screws to enable the operator to regulate the tension of his lap.



Machinery,N.Y.

Fig. 8. Master Ring Gage with Small Collar at Mouth of Hole, which is ground off just before completing the lapping

The piece to be lapped should be running at the speed required in grinding, which varies according to diameter, and the lap adjusted at all times to grip firmly on the surface, but sufficiently free to allow its being held by the fingers. In the case of large work a wood clamp can be used. As the piece revolves, the lap is slowly drawn back and forth from end to end, and under no circumstances should this oscillation cease while the plug is in motion.

The proper abrasive to use in this operation is flour of emery, or a very fine grade of carborundum; the latter, being the faster cutter, seems more desirable. It is mixed with sperm or lard oil, to the consistency of molasses, and applied sparingly to the surface being treated, from whence it is taken up by the lap, which becomes charged as it passes over after each application.

As the operation is almost completed, however, this is discontinued, and a drop or two of oil charged with the finest particles of flour emery is substituted. This is obtained by sifting as from a pepper shaker about a tablespoonful of flour emery into a tumbler of lard oil, when, after standing an hour, the oil should be poured off, and will be found charged with the finest emery, the coarse particles having settled to the bottom. This abrasive is applied a drop at a time from the end of a small pointed stick or wire, and will make a remarkably smooth and bright finish. To the practiced hand, it requires very little time to lap a piece in this manner.

Should it be necessary to remove any quantity of metal by the lapping process, much faster methods can be employed, such as lead or copper laps charged with a coarse abrasive liberally applied; but the results will be found hardly satisfactory if accuracy is desired.

Should there be any hitherto undiscovered soft spots in the piece, they will invariably show up in the lapping, as their duller color is contrasted with the rest of the harder surface. However, it is possible for a piece to be slightly soft throughout, and finish up uniformly bright, but the softness should be discovered by file or other test at an earlier stage. In either case the piece can only be rehardened, and reworked for some smaller size, as a plug gage with a soft spot on its surface is useless.

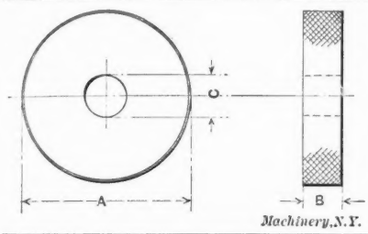
Ring Gages

When ring gages are to be made in quantity even when the quantity is small, they should be made from tool steel disks turned to certain standard diameters and cut from the bar. These blanks can be kept in stock, as well as the holders (see Figs. 1 and 5) into which they are forced after being drilled, reamed and hardened. The holders are made on a screw machine, of machine steel, requiring only to be turned, knurled, drilled and reamed with a slightly smaller hole than the diameter of the corresponding gage blanks, and cut off to length. They can be treated similarly to plug handles as to marking and bluing, as occasion demands; they can be used indefinitely by replacing the ring bushing when worn.

The gage blanks are drilled and reamed, or bored, to within 0.002 or 0.003 inch of the finished size, care being taken to have the hole as straight as possible. In handling for harden-

ing they are wired around the outside with a short piece of soft iron wire, to afford a means of handling and avoid the contact of tongs, or the necessity of passing a rod through the hole in dipping, as this latter has a tendency to cause bell mouth by retarding the action of the water within the hole. After hardening they are at once reheated sufficiently to relieve the strain, as in the case of plug gages. They are then ground on an arbor, allowing about 0.0015 inch to insure a tight fit in the holder, and are then rough lapped within 0.0005 inch of the finished size, pressed into place,

TABLE II. RING GAGE HOLDERS



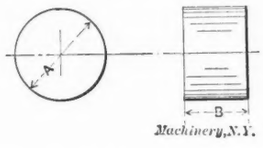
No.	A	B	C
	Inch	Inch	Inch
1	$1\frac{1}{8}$	$\frac{1}{4}$	$\frac{5}{16}$
2	$1\frac{1}{4}$	$\frac{5}{16}$	$\frac{7}{16}$
3	$1\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{2}$
4	$1\frac{1}{2}$	$\frac{7}{16}$	$\frac{5}{8}$
5	$1\frac{7}{8}$	$\frac{11}{16}$	$\frac{7}{8}$
6	$2\frac{1}{8}$	$\frac{11}{16}$	$1\frac{1}{8}$

and finish lapped. The ends can be ground while on the arbor or on a surface grinder when in the holder, but before the finish lapping.

If the rings are sufficiently large to require grinding they should first be ground on the periphery to the proper diameter, and then on the inside to within about 0.001 inch of the finished size. As holes ground with a wheel are liable to be slightly tapering, they cannot safely be worked as close as a plug, in the grinding. It is an unnecessary expense to wheel grind rings up to ¾ inch diameter, as simple lapping gives equally good results and requires much less time.

The form of lap used (Figs. 6 and 7) is a cast iron cylinder with a taper hole, split diagonally on one side to allow of expansion as it is forced on a taper arbor, to compensate for the gradual enlarging of the hole being lapped. The lap should be about three times the length of the ring it is intended to be used in. The same rules regarding abrasive, speed, etc., apply as in the lapping of plug gages, but care should be exercised to avoid a too generous application of the abrasive as the process nears completion, for, if applied too lavishly the particles have a tendency to crowd under the edges and cause a bell mouth effect. This latter trouble is sometimes eliminated by making the rings with a slight

TABLE III. PLUG GAGE BLANKS



No.	A	B	C	D	No. of Handle
	Inch	Inch	Inch	Inch	
1	$\frac{1}{8}$	0.100	$\frac{5}{8}$	$\frac{3}{4}$ to $1\frac{1}{4}$	1
2	$\frac{3}{16}$	0.150	$\frac{7}{8}$	1 to $1\frac{1}{8}$	2
3	$\frac{1}{4}$	0.200	$1\frac{1}{4}$	1 to 2	3
4	$\frac{3}{8}$	0.300	$1\frac{1}{4}$	$1\frac{1}{8}$ to 2	4
5	$\frac{5}{16}$	0.300	$1\frac{1}{4}$	$1\frac{1}{8}$ to 2	4
6	$\frac{3}{8}$	0.400	$1\frac{1}{4}$	$1\frac{1}{4}$ to 2	5
7	$\frac{7}{16}$	0.400	$1\frac{1}{4}$	$1\frac{1}{4}$ to 2	5
8	$\frac{1}{2}$	0.400	$1\frac{1}{4}$	$1\frac{1}{4}$ to $2\frac{1}{4}$	5
9	$\frac{5}{8}$	0.500	$1\frac{3}{8}$	$1\frac{1}{2}$ to $2\frac{1}{4}$	6
10	$\frac{5}{8}$	0.500	$1\frac{3}{8}$	$1\frac{1}{2}$ to $2\frac{1}{4}$	6
11	$\frac{7}{8}$	0.500	$1\frac{3}{8}$	$1\frac{3}{4}$ to $2\frac{1}{4}$	6

collar on each end (see Fig. 8), which is ground off after the rough lapping has been completed; but this is somewhat expensive, and except for master rings, hardly necessary.

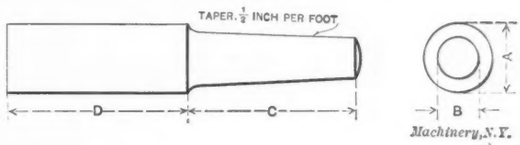
In the making of small ring gages which do not allow the insertion of a substantial cast iron lap, a tool steel lap charged with diamond dust can be used. This abrasive, which is not extensively used outside the watch factories and concerns doing work of like nature, must be used to be appreciated. It can be purchased as Brazilian bort, in a pebbly form; crushed in a suitable mortar, and graded to suit requirements; it is particularly applicable to hand or form laps, or laps for delicate or sharp corners. It is also a very rapid and smooth cutter, economical and lasting, and is readily taken up and retained on the surface of a tool steel lap to which a very small quantity is applied mixed with sperm oil, and rolled in with an extremely hard roll. Occasional rechargings are necessary as the work progresses, but in the intervals a drop of sperm oil is used on the lap.

Should it be required to make master or reference plug and ring gages, a somewhat different course should be followed than for gages intended for continual use. The method is about the same in each case, but with the former, after hardening, the work should be carried along at intervals, over a considerable time. First the rings should be cleaned up on the grinder and laid away, and later ground again, and so on during the course of a year, or even longer, where future requirements are being anticipated. This allows the metal to set, or as called by some, to season.

The Measuring and Fitting of Plug and Ring Gages

In factories not equipped with a measuring machine, some sort of standard should be adopted to which each and every workman can adjust his measuring tools. As few men measure alike, the disadvantages of varied adjustment are added, and the result is hardly conducive to uniformity. A first-

TABLE IV. RING GAGE BLANKS



No.	A	B	Finished Hole	No. of Holder
	Inch	Inch	Inch	
1	0.350	0.300	0 to 0.150	1
2	0.475	0.350	0.150 to 0.300	2
3	0.600	0.400	0.300 to 0.400	3
4	0.725	0.500	0.400 to 0.500	4
5	0.975	0.750	0.500 to 0.750	5
6	1.225	0.750	0.750 to 1.000	6

class gage maker has in his kit reserve micrometers, which are properly adjusted to the standard of his employer, and used only for reference or final measurements. This allows him to work to a remarkable degree of closeness before presenting his work for test, should a measuring machine be employed for that purpose; and where it is not, the work is usually inspected by one man, equipped with no better means of measuring than the maker's, but who serves to unify the element of touch which varies with different workmen.

Where master plug and ring gages are desired in pairs, the plug is first made to measurement, and the ring is then made and fitted to the plug. When trying the ring on the plug during the final fitting, both should be wiped perfectly clean and allowed to acquire like temperature, by lying together on a bench, or machine, or for a few seconds in cold water. The plug is then given a slight coating of rancid oil, and inserted in the ring, into which it should be a close wringing fit. When fitted properly this way, it will be found impossible to insert the plug, should the oil be removed, or even when some other kinds of oil are substituted. This rancid oil is simply the drippings of animal oil that has been used many times on some drilling or cutting operation; the older it is the better.

Should a number of plug gages of one size be required for manufacturing purposes, they should all be made to machine or micrometer measurement. It is utter folly to try fitting any quantity of plugs to one master ring if absolute uniformity is essential, particularly if they are of any considerable length, owing to the tendency of the ring to wear in the fitting. One of each lot can be tested to the ring to make sure that it conforms to the proper standard.

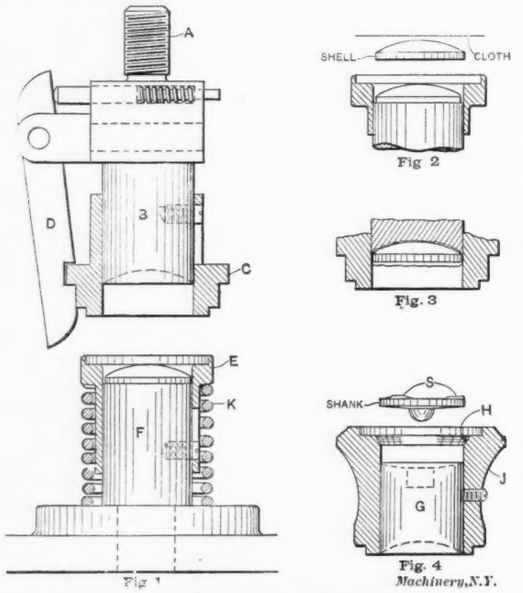
Ring gages, whether made singly or in quantity, are fitted to a master plug, which, as it wears, is comparatively inexpensive to replace, the wear being easily detected by occasional reference to the master ring.

DIES FOR COVERING BUTTONS

CHARLES WESLOW*

Charles Weslow†

The dies and tools used in the manufacture of cloth covered buttons are shown in the accompanying illustrations. The particular tools shown are for covering and binding together the two parts of what is known as a "fifty line unlined tablet button." One "line" on a button gage is equivalent to 0.025 inch or forty lines to the inch. The dies are used in a foot press of simple construction, this machine being adapted for this work. The ram of the press is tapped for the threaded shank *A*, Fig. 1. The case-hardened part *B* is finished to a diameter of 49¾ lines or 1.243 inch, and its lower end is concaved according to the style of shell or button. The sleeve *C*, which is bored 0.001 inch larger than part *B*, is made of machine steel and also case-hardened. This sleeve is supported by a lever *D*, during part of the time required for the covering operation, and it is provided with an elongated slot which fits the head of a small screw, as shown. Another case-hardened machine steel sleeve *E*, similar to *C*, fits over the part *F* which is likewise similar to the part *B* except that it is convex on the upper end to conform to the shape of the inner part of the button shell. This spring-supported sleeve *E* is the lower die. The diameter of *F*, except the small shoulder at the upper end, is 0.002 inch larger than the shell, the size of which depends on the thickness of the cloth used, which in this case is ¼ of a line or approximately 0.006 inch. This size shell is made of 36-gage stock. The largest bore of sleeve *E*, which is known as "the nest," is the same diameter as the cloth blank which is computed according to the style of the button. In this case it is 69 lines in diameter.



Figs. 1 to 4. Die and Thimble for Covering Buttons and Binding Shank and Collet together

The different parts of a button are shown in Fig. 5. The cloth blank in the upper left-hand corner of the engraving, covers the shell to the right, and this covered part is locked to the collet shown below after a piece of cardboard and canvas has been placed in position as subsequently described.

In Fig. 2 the shell and cloth blank are shown ready to be placed in the lower die. When they are in position the upper die descends and picks them up, as shown in Fig. 3. The part shown in Fig. 4 is known as a thimble. This thimble, which is of tool steel, acts as a closing or curling die, at *H*, and it not only curls the cloth between the shell and the shank, but it also closes in the shell thus binding or locking the two parts together. The radius of the surface *H* is found by experiment. The shank is shown in Fig. 4 ready to be placed in the thimble. When in position it rests on the plunger *G*, which is a sliding fit in the thimble. This plunger is prevented from dropping out by a set-screw, which engages an elongated flat spot on it. The largest bore of the thimble is the same diameter as the lower outside diameter of sleeve *C*, which is the same as the recess in part *E*, which, as stated, corresponds to the diameter of the cloth blank.

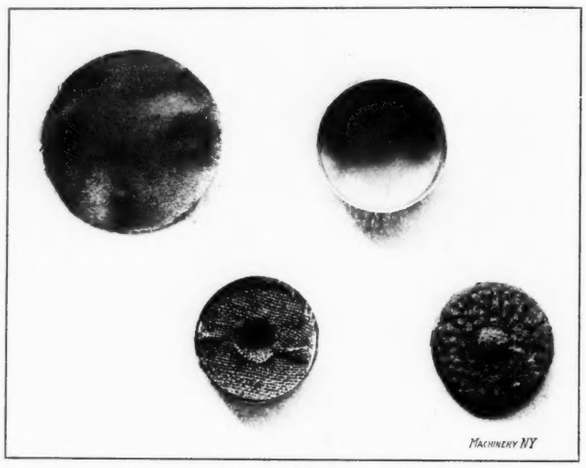


Fig. 5. The Parts of a Cloth-covered Button

Figs. 6 and 7 show the thimble in position for the second downward movement of the plunger. The thimble is put in place by hand after a shell and cloth cover have been picked up by sleeve *C* during the first stroke of the press, as shown in Fig. 3. The parts *C*, *J* and *E* are supported by the spiral spring *K*. When the upper die descends during the second stroke, lever *D* is disengaged from sleeve *C*, as shown in Fig. 7, so that the latter is free to move on part *B*, which continues to move downward when *C* rests on thimble *J*. In so doing, it forces the cloth cover to curl in as shown. Then the cylindrical part of the shell, which is now covered, strikes the curling section of part *J*, but the spiral spring now gives way to this pressure, so instead of the metal shell curling in as might be supposed, it acts in connection with part *B* to force thimble *J* down, which, in turn, acts likewise upon the sleeve *E*, which moves down until its lower end strikes the die-bed. By this time the shank will have entered the shell and carried the surplus of cloth cover with it. When sleeve *E* stops on the die-bed, part *B* continues to descend until the shoulder on it strikes the upper end of sleeve *C*; then there is nothing else for the invisible shell to do but curl in and embrace the shank, thereby locking them together and completing the button. Sufficient expansion takes place in the button, when the dies are released, to cause it to float on the top of the thimble. So it will be seen that two "kicks" or strokes of the press are required to cover a plain button.

In considering the manufacture of the five parts necessary in a plain button, we will first take up the shell and collet. These are blanked and drawn up in a combination die, known as a collet die, with a double action press, but not necessarily so. Stock of from 36 to 38 gage is used to make them, which comes in sheets of various sizes in much the same manner as tin. Some manufacturers get the 14 by 28-inch size and square shear them in half for convenience. The material used for shells is given a thin coat of japan to prevent rusting, but the material used for the collets is japanned black for appearance.

The stock is fed by hand up to a knife-edge stop, which is instrumental in separating the scrap stock from the sheet.

* Address: 332 Jersey St., Harrison, N. J.

† Chas. Weslow was born in Harrison, N. J., in 1876. He began work at the age of 11 years, out of necessity, and since that time he has been employed in a great many machine shops and manufacturing establishments in the East, as machinist, tool-maker, and tool designer. In this journeying, he has acquired a broad practical experience, which has been supplemented by the correspondence and night schools. The following are a few of the numerous establishments where he has been employed as tool-maker or executive: Noble & Hunt, Newark, N. J.; Western Electric Co., New York; Sloan & Chase, Newark, N. J.; Domestic Sewing Machine Co., Newark, N. J.; F. H. Richards Engineering Co., New York; Pike Adding Machine Co., Orange, N. J.; American Calculating Machine Co., Newark, N. J.; Crown Button Co., New York; Hyatt Roller Bearing Co., Harrison, N. J.; Premo-Hall Novelty Works, Newark, N. J.

The edge of the stock, after one row of blanks has been cut, is made up of half-circular forms, as shown in Fig. 8. This rough edge, however, is placed against the gage on the press when blanking to the succeeding rows, to guide the stock as it is being fed through, the gage being long enough to make it easy for the operator to hold the stock squarely against it. The press runs about 250 revolutions per minute, and the shells are blown from the die by a strong air blast. Some use an inclined press, relying upon gravity to remove the shell, but an air blast does the work quicker, thereby allowing a speedier action of the press. This blast comes through a 2½-inch tin pipe, which is nozzled at the die. After the first row of blanks is cut from the new edge of

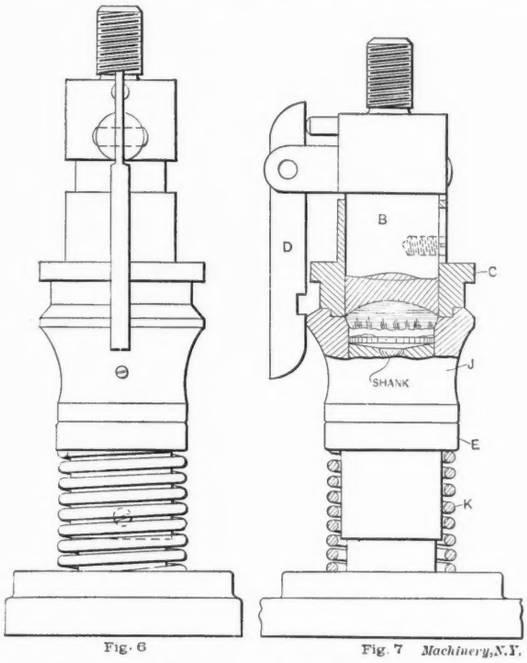


Fig. 6 Fig. 7 *Machinery,N.Y.*

Figs. 6 and 7. Die shown in Fig 1, with Thimble, Fig. 4, in Place

stock, the operator snips off the corner with a pair of scissors to prepare the stock for blanking the next row of holes. By carefully trimming the corner, the stock is so located by the knife-edge stop *S*, Fig. 9, that the blanks are cut as indicated by the dotted lines in Fig. 10, which, of course, effects a considerable saving in material. The first blank is cut singly to locate it properly and then the balance are cut out at a speed depending on the speed of the press. By referring to the engraving, Fig. 10, it will be noticed that no stock remains between the blanked holes. As the stock is fed forward a knife-edge stop effects a separation of the scrap from the sheet.

Another part to the button is the cloth cover. These are cut with a hand punch, which looks like a large size belt

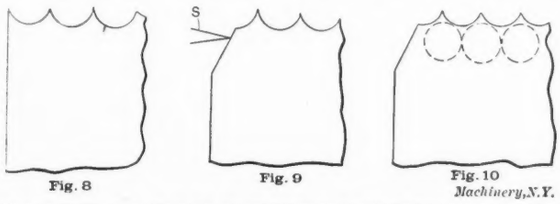


Fig. 8 Fig. 9 Fig. 10 *Machinery,N.Y.*

Figs. 8 to 10. The Way the Stock is located with Reference to the Stop to effect Economical Blanking

punch, and a mallet on a hardwood block. Several thicknesses of cloth are cut at one blow, and about ½ gross of the blanks are removed from the punch at one time. A good plan is to keep the cloth blanks in the position in which they are taken from the punch, in a receptacle for this purpose, instead of throwing them loosely into an open box. If the button is to be covered with a damask material, or fancy centers, as shown in Fig. 11, then the blanks are cut singly in a foot press.

The cardboard disks, which are inserted between the shell and collet, are cut on the single action power press in much the same manner as the shells are made, but they are forced through the die, while the shanks are knocked out. These "cardboards," as they are called, are rushed out "a mile a minute," no particular care being exercised, for if they crack or break, they are used anyhow, but they must be a certain

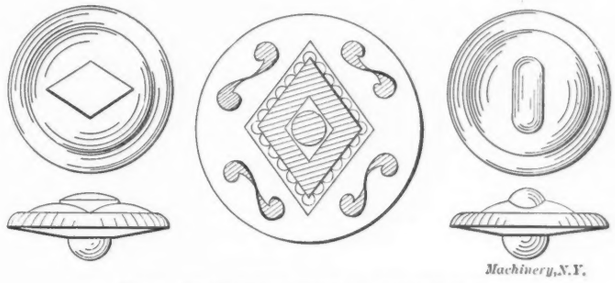


Fig. 11. Fancy Covers which are blanked singly

size to drive into the collet, to hold the canvas in position. The canvas pieces are blanked in much the same way as the cloth covers are. These parts are assembled in what is called a "machine," but it is in reality a light foot press built on the lines of general hardware.

Fig. 12 shows the style of die used in assembling the shanks. Two strokes of the press are required for each shank. The illustration also shows the shell and the canvas blank ready to be placed in the "nest." The punch *P* is shaped the same as an ordinary drawing punch, excepting the hemispherical projection provided at the end. This end is what forms the canvas stem which is sewed to a garment. In use, the collet is first placed in the nest with the canvas on top. The plunger then descends and forces the canvas into the pierced hole in the collet forming the stem. The lower end of the knurled ring *R* is turned to fit the recess in the upper end of part *Q*. This ring contains a plunger,

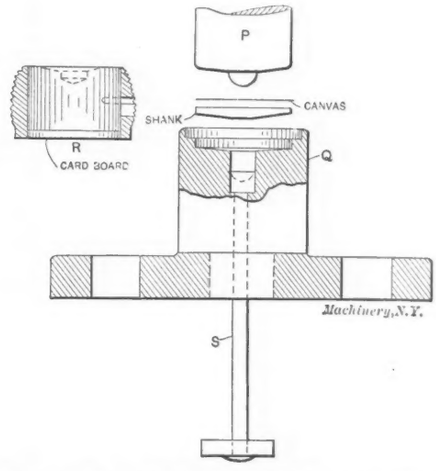


Fig. 12. Punch and Die for Forcing Canvas and Cardboard into the Button Shank

the top end of which is turned to fit the lower end of plunger *P*. The ring and its plunger are held together by a small dowel, as shown, which slides in an elongated slot in the ring. While the operator is forcing the canvas into place, this ring, which is held in the right hand, is being used to pick up a pasteboard disk, while the left hand secures another canvas and collet for the next button. After the first stroke of the plunger *P*, the knurled ring is inserted in the recess in *Q*. The second stroke, through the plunger in ring *R*, imparts a blow to the pasteboard, which is driven into the shank. The small plunger *S* is a simple form of knock-out for ejecting the shanks. Celluloid buttons are assembled in the same style die except that celluloid covers are first heated to make them pliable so they will curl and bend.

Good tool-makers are in demand for this work, and the writer knows of concerns who were offering $24 and $30 a week for competent men. As far as the writer knows, Williston of East Hampton, Mass., is the original covered button manufacturer, now known as the United Button Co.

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MACHINERY

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INVENTING AS AN OCCUPATION

From time to time our mail brings a woeful tale from a disappointed inventor who has devoted a number of years and considerable money to the perfecting of some device which the world has not duly appreciated. Many inventors spend years on the development of an idea which to them appears to be of great value. Often, too, they sacrifice the employment by which they earn their daily bread. It is but natural that the inventor who has thus devoted his time and perhaps all of his savings to the development of a new idea should be discouraged when he finds that he can realize little or no returns from his invention. As a rule he thinks that he has been unjustly treated by those to whom he has submitted his idea and often regards the manufacturer as an enemy because the compensation offered is from his point of view inadequate.

In many cases the inventor sees from one viewpoint only. He has not the advantage of wide experience and knows little or nothing of the costly organization necessary for marketing goods. Inventing should seldom be considered as an occupation to which a man can profitably devote all his time, except in cases where the inventor's genius is of an extraordinary degree. The inventors who succeed as a rule retain employment in regular occupations while they perfect their inventions during spare time, the inventions being incidents in their regular occupations, or by-products, as it were. When an inventor works under such conditions he is more likely to correctly estimate the value of his inventions, and not be bitterly disappointed because his inventive genius is not highly appreciated.

A man who has true inventive genius cannot help being an inventor, but he should avoid living in expectation that one brilliant idea will make his fortune and enable him to live ever after free from all pecuniary cares. The hope of "striking it rich" is a common fault of many inventors. If they must invent, let them content themselves with moderate returns for their ideas, placing each in the best market possible, but not feeling disappointed if a large fortune is not realized from an idea that to the inventor seems very valuable.

Advice is cheap and is generally disregarded by those who could best profit by it. But notwithstanding, we cannot help suggesting that inventors of ordinary ability should retain their regular occupations while developing their ideas. They will be happier and their chances for success will be greater than if they give up profitable occupations hoping to produce something which will make a large fortune. The trouble is that inventors as a class are a somewhat irresponsible lot to whom a steady job is distasteful. Steadiness of character and genius are rarely found combined in the same individual, and doubtless much that has been said here will be of little value to the class most in need of advice.

* * *

MACHINE SHOP INTERCOMMUNICATION

There is no trade or profession so closely identified with the development of new inventions as that of the machinist and the tool-maker. Embryonic ideas are gradually developed through a series of experiments with their assistance, and when the model is finally completed, the tools and machines for its manufacture have to be constructed. The position of the up-to-date machine shop, therefore, is of the first importance in industrial development. It is this importance which has made it absolutely imperative that the equipment of machine shops be of the highest type in labor-reducing machines and time-saving methods.

One of the many important time-saving devices developed within the past few years, which merits the careful attention of shop managers, is the automatic intercommunicating telephone. Its installation in a plant means that machine shop superintendents are no longer subjected to the many annoyances occasioned in the past by the crude methods of communication in use, such as unreliable hand-bells, buzzers, unsanitary speaking tubes, etc.

The very nature of the modern machine shop organization with its various departments covering a large ground area demands that some quick method of communication be installed that will put every department in close touch with any and every other department. It should not be necessary for the foreman of, say, the milling department to go to the foundry to ascertain why certain castings required for a rush order have not reached him. His time is too valuable to be thus wasted. Again, the shipping department, located perhaps in a remote part of the works, should be in as close touch with the superintendent as the drafting-room just outside his office.

The automatic intercommunicating telephone, of which various forms are now on the market, brings all the departments of the modern machine shop in close touch with each other without involving charges for attendants. With its use a higher standard of efficiency can be obtained, and almost all the benefits of personal interviews can be enjoyed without the necessity of leaving one's own department. The old walking-talking method of communication between the superintendent and subordinates may be abolished and the time thereby saved devoted to other details. Orders can be transmitted and received almost instantaneously, and mistakes practically eliminated, or at least reduced to a minimum on account of the facility provided for readily securing directions and checking up doubtful information. The telephone should not, of course, be used to transmit orders of which a record is required. All such orders, requisitions, data, etc., should be transmitted in writing only; but the telephone can be made a most valuable means for explaining points not clear in written communications or which perhaps need modification in some detail to fit a certain condition.

Another advantage of the telephone not unimportant is the ready means it gives for locating the superintendent or others who may be making a tour through the works. In a few moments all the stations can be called up if necessary, the desired persons located, and any communication transmitted or information obtained with promptness.

All the foregoing and much more is common knowledge in the works where the telephone is an indispensable fixture, but notwithstanding its manifest advantages we still find many plants, otherwise up-to-date, which are sadly deficient in modern means of intercommunication. The defect can be remedied at small expense, and the saving effected will soon more than pay the cost.

THE HUMAN ELEMENT

ANALYST

Among the potent factors that impel a manufacturing concern toward the goal of commercial supremacy, is one that is often overlooked, but more frequently ignored—the human element. Employers sometimes forget that there is such a thing as a moral law and that it does not pay to violate it, and some superintendents and foremen have been imprudent enough to take undue advantage of the recent industrial depression to enforce methods and policies vitally affecting the workman's daily life, without regard to the human element that enters into his makeup, and which of necessity must be reckoned with later on.

As a consequence the men usually "take it out" by giving the company a bad reputation among their fellow-workmen, and it is a fact that some of the concerns which complain of the difficulty of securing and keeping good men, owe their troubles largely to this cause. The reputation of a shop for being "white" or otherwise spreads far and wide, and good men usually know pretty accurately whether it is a desirable place to work in or not. This often materially affects the establishment concerned, especially when good men are scarce. Business men have their commercial agencies and reports for ascertaining the reputation and standing of other concerns. Workmen do it by a different, but just as effective a method, and the superintendent or foreman who thinks he can treat men unfairly and not suffer for it makes a great mistake. The foremen, especially, should always remember that they are the direct representatives of the firm to the workmen, and that the men base their opinion of the company largely upon their opinion of the foremen. The workmen's promotions and increases in pay depend upon the foremen's characteristics and knowledge; their daily life and career are subject to his control, his caprice and vagaries. The character and ability of the foremen affect the workmen more directly than any other factor in the shop organization, and as a result have a direct effect upon their efficiency and disposition toward the company. Of course there are always two sides to a story. Many of the complaints come from men who are chronic fault finders, and who never would be satisfied with any conditions, however advantageous; so that before giving credence to these reports, one should always be certain that the facts are substantiated by reliable evidence.

We often hear of the tendency of workmen to limit their output and effort, and of their neglect to work for the good of their employers. This is usually the complaint of the manufacturer who does not consider the human element of sufficient importance to merit his attention, and who refuses to put himself in the other fellow's place and to build up an organization along lines which would mean encouragement and inspiration to his employes.

Another factor of great importance in its effect upon the human element, is the question of handling men so as to get the most out of them without incurring their enmity.

Ignorance of details will sometimes cause the management of a concern to entrust the important position of superintendent to the man who can talk loudest and make the greatest show on a little knowledge. Such a man is apt to possess an exaggerated sense of his own importance, coupled with jealousy of those who suggest any improvement in method or process. Add to these failings surreptitious dealings with foremen and workmen, and you have three of the greatest causes of trouble in a shop, resulting oftener in a spirit of hostility than of cooperation between superintendent, foreman and workman.

It sometimes happens that a superintendent makes the serious mistake of ignoring his foremen to a certain extent in order to display his authority, and instead of entrusting the details of the work to the foremen, gives orders directly to the workmen; so that the workmen lose respect for and confidence in their foremen, and the latter become mere figure-heads, without any authority except in minor details. In some cases this is necessary because of the incapacity of the ordinary foreman, but it is always advisable when practicable to give instructions through the foreman, and if he is not competent to run his department without such assistance he should be replaced by one who is.

It frequently happens that a superintendent desiring to retain the full credit for an innovation, makes the mistake of refusing to confer with different members of his organization in regard to any suggestion they may be able to offer, and attempts to force his plans through. Such action usually meets with covert opposition. His assistants, perhaps familiar with some obstacle in practice which he has not considered, say nothing and allow the experiment to fail, "because they weren't asked." In this way the small jealousy that impels one man or group of men to underrate the work done by others, often works incalculable loss to the employer. The fact must be recognized that, nine times out of ten, the joint advice of several men conversant with a subject is superior to any plan developed from one man's brain.

In every organization there should be a head and a strong one; but singularly enough the method often adopted in manufacturing establishments is to place all the responsibility on one superintendent and neglect to surround and strengthen him with a body of efficient foremen, who might be advisers of great value. In adopting such a policy the management fails to recognize the great benefit to be derived from securing the advice of a number of the best qualified men upon important matters, and from giving the foremen an opportunity to show their value, which with most men means increased ability to handle the problems submitted to them.

In contradistinction to the method of management portrayed above, is the shop organized along lines that enlist the cooperation of the personnel, that develops the latent ability of each man; a shop where all plans are based primarily upon the human element of the men who are affected. The sympathetic support of the foremen and workmen *must* be secured. The best qualified superintendent will not achieve the degree of success that should be attained unless he is supported by the foremen, job-bosses and workmen. To enlist their support, they must be consulted frequently concerning the difficulties encountered, and encouraged to suggest ways of overcoming them; they must be made to feel that the methods are their own, and their interest in the work recognized. Thus difficulties will quickly disappear, and ways and means for overcoming unexpected obstacles will soon be discovered.

Nothing is more vital to the progress of an enterprise than that its executive force should work in unison. Then the balance of the shop will generally do likewise. Let there be discord and lack of harmony among the heads of a concern and there will be an instant lining up of forces in opposition, one against the other, which will cause the entire organization to disintegrate and lose much of its efficiency. The only cure is cooperation, since the work of each man is related to and interlaced with the work of all. The spirit of "getting together," if fostered, will be the chief factor in developing the strong men in the organization, and it should always be remembered that the habit of concerted action can be cultivated—gradually, perhaps, but easily—if proper attention is paid to it.

It must be conceded that the humanitarian, fair-minded policy of management is the greatest stimulus to the ambition of the workmen, and that a loyal, interested force of workers, impelled by a feeling of good fellowship to do their level best, constitutes the concern's best asset, and is the greatest and strongest factor making toward success.

* * *

It is evident that Bleriot's exploit in flying across the English Channel has stirred the imagination as has no land flight of equal distance, and that it has also greatly stimulated the progress and development of aviation.

The enthusiasts see in Bleriot's flight the beginning of a new era in which man will conquer the air, and in which the sea, "that parts nations asunder," will no longer be a hindrance to his movements. To us there is something essentially fine, heroic and conquering in the vision of the Frenchman's exploit; it shows man overcoming the seemingly insurmountable through his control of natural forces, made possible by the development of mechanical engineering. The machinist can rightly claim a large share in this latest triumph of mechanical flight.

THE TESTING OF FILES AND TOOL STEEL*

The following inquiry regarding files has been made not merely for the benefit of the file-maker, but quite as largely for the benefit of the buyer and user of files. The subject, therefore, is treated from the standpoint of a practical engineer without any special knowledge of file making.

The testing of files is accomplished by means of a special machine (see description in MACHINERY, December, 1907, engineering edition) which records the endurance and metal-removing qualities of the file on a piece of paper wound around a cylinder, thereby producing diagrams as shown in Figs. 1 and 2. In these diagrams the horizontal distances represent the number of strokes made by the file tested, and the vertical distances the number of cubic inches of metal removed during the life of the file. The curves drawn in Fig. 1 show the life history of two files from the time when they were new until they were completely worn out. It will thus be seen, for instance, that one file removed somewhat

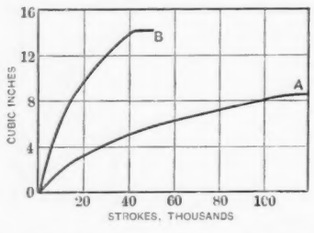

Fig. 1. Diagram resulting from File Tests on Steel, made on the Herbert File Testing Machine

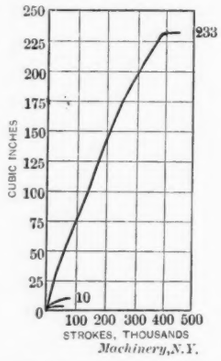

Fig. 2. Diagram resulting from File Tests on Cast Iron

over eight cubic inches of steel in 108,000 strokes, after which the file was incapable of removing any more metal. The other file removed the same amount of material in the first 16,000 strokes, and was still in good condition, removing a total of 14 cubic inches in 42,000 strokes before worn out. In Fig. 2 is shown even a more striking comparison, and here the great variation in the amount of work possible from files of different quality is exhibited. The two sides of one file removed 10 and 3 cubic inches, respectively, of cast iron before becoming too blunt to cut, while one side of another file reduced to filings nearly 20 feet of a cast iron bar one inch square before unable to cut. These examples indicate that file testing is a matter of considerable importance in shop economy, particularly in the assembling department where a great deal of time may be wasted by using inferior files.

The files are tested until they slip over the surface of the test bar without cutting, this condition being shown by the curves taking a horizontal course. Tests which are stopped before this point is reached may give a false impression as to the relative merits of files. It may happen that two files cut equally well during the first 50,000 strokes, and if the tests were stopped at this point the files would be considered equal. If the tests were continued, one file might cease cutting at 60,000 strokes, and the other continue for 400,000 strokes, thus showing a great difference in their durability.

Results and Conclusions of File Testing

Among the results obtained by the file-testing machine, perhaps none is of more interest than the discovery that the two sides of a file are seldom equal in efficiency and durability. Fig. 3 shows the curves for the two sides of the same file, one of which accomplished three and one-half times as much work and made four times as many strokes as the other. Such results are common. File-makers generally explain this difference as due to a variation in the sharpness of the chisel used in cutting the files. If a great variation is thus found between the sides of a file, it is likely that equally great variations will be found between individual files in the same lot, this being an evidence of lack of uniformity in the manufacturing process. One of the most important services, therefore, that is rendered by the file-testing machine to makers and users of files, is that of showing the great difference caused by minute variations in the shape of the file teeth, variations which can scarcely be detected by examination, and which can only be eliminated by extreme care in all the processes of manufacture.

It has been assumed that a file made of good steel is a good file. The teeth, of course, are expected to feel sharp, but beyond this very little attention has been paid to their shape. The file-testing machine has shown that the shape has a far greater influence than the quality of the steel, not only on the rate of cutting, but also on the amount of work that can be got out of the file. Fig. 5 shows the curves obtained from tests where five files were worn out at practically the same number of strokes (110,000). The amount of iron filed away varied very greatly. These variations in rate of cutting are more marked on cast iron than on steel. The best file in Fig. 5 cut when new at the rate of 14 cubic inches per 10,000 strokes, while the poorest file cut hardly more than ½ cubic inch during the same number of strokes, the material being cast iron. On steel a rate of 6 cubic inches per 10,000 strokes is rarely exceeded.

The rate of cutting is given by the slope of the curve and depends almost exclusively on the shape and sharpness of the teeth and on their relation to one another, and is not affected by the quality of the steel. As many files cut at a very slow rate when considerably worn, it is economical to reject files at a fairly early stage of bluntness.

Factors Determining Efficiency of Files

The chief factors by which the cutting efficiency of a file is determined are:

1. Sharpness of teeth.
2. Slope of the front face of the teeth, or rake.
3. Slope of the back face of the teeth, or clearance.

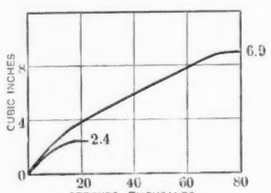

Fig. 3

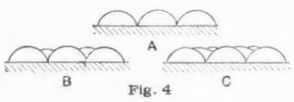

Fig. 4

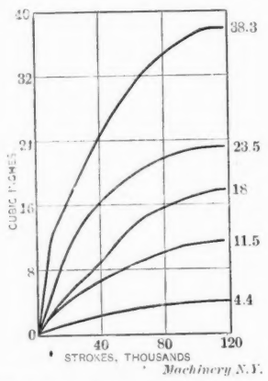

Fig. 3. Curves resulting from Tests of Two Sides of the Same File cutting the Same Material. Fig. 4. Arrangement of File Teeth, due to Variation in Ratio between "Up-cut" and "Over-cut." Fig. 5. Five Files of Equal Durability, but Unequal Capacity for Removing Metal

4 and 5. Angles of the two cuts relative to the axis of the file.

6. Pitch or coarseness of the cut.

7. Ratio between the pitch or number of cuts per inch in the "up-cut" and in the "over-cut."

At first sight it would seem that the sharpness of the teeth would be the most important factor in cutting efficiency, but the experiments indicate that this is not the case. Two files equally sharp, and thus cutting equally fast when new, do not show the same efficiency.

The slope of the front face of the teeth on commercial files as made at present is very rarely vertical, but in almost all cases there is a negative rake varying from 3 to 25 degrees. Experience with lathe and planer tools would lead one to expect that a tool with considerable negative rake would be exceedingly inefficient on almost all materials, and it is surprising that such a tool cuts at all under such light pressure as can be applied by hand on a file. Nevertheless it is a fact that files with considerable negative rake not only cut, but take off very satisfactory curled chips. The reason

* Abstract of paper by Edward G. Herbert, read before the Manchester Association of Engineers, March 27, 1909. For description of the file-testing machine referred to, see MACHINERY, December, 1907, engineering edition.

for this is probably that the file tooth is presented to its work at an angle, owing to the slope of the cut across the file. This gives a slicing cut, which probably accounts for this efficiency.

The slope of the back face of the tooth, or clearance, is very difficult to measure because it is not a plane surface, but the angle is very important in relation to the durability of the file. A file which is worn out has the tops of its teeth flattened or rounded. When the area of contact of the teeth with the work attains a certain value, great pressure is required to cause the teeth to "bite" the metal. The amount of work that can be obtained from a file, therefore, depends largely on the volume of teeth available for wear before this limiting area is obtained.

Examination of commercial files show that these angles are extremely variable, and it is certain that uniformly satisfactory results cannot be obtained unless correct angles are ascertained and maintained, leaving nothing for the variation of judgment on the part of the workmen. The pitch or coarseness of the cut does not seem to influence the efficiency of files to any great extent. Very coarse files, however, are almost always inefficient, probably because of the difficulty of raising very large teeth, which are at the same time sufficiently thin and sharp. Very smooth files, on the other hand, cut slower and do less work than those of somewhat coarser cut, but in some cases surprising results have been obtained from smooth files also.

It may not be generally known that the two cuts on a file differ in pitch. Suppose a file had 25 cuts in the chief or "up-cut." If it has also 25 cuts per inch in the secondary or "over-cut" a cross-section of the file would appear as at *A*, Fig. 4, each tooth standing immediately behind a tooth in the row in front, and all the teeth lying in straight rows parallel to the axis of the file. Such a file would leave on the surface of the work a series of furrows with ridges between them. Now suppose that there be 25 cuts per inch in the "up-cut," but the "over-cut" is made with 16¾ cuts per inch. Then the appearance of the cross-section would be as at *B*. Each tooth now lies opposite the space between the two teeth in the row in front. The teeth in the first row still make a series of furrows, and the teeth in the second row work on the ridges between these furrows, planing them off and leaving a fresh series of furrows, but the file would be inefficient because the ridge between any two teeth would be too large to be taken off at one cut by the teeth behind. If the number of teeth per inch in the "over-cut" is increased to 19, the effect will be as shown at *C*; the ridges between the teeth in the first row are divided between the teeth in the second and third rows behind. This subject of the ratio between the "up-cut" and "over-cut" is likely to be one of the most important factors in file efficiency, but it has not as yet been thoroughly investigated.

Efficiency of Files on Various Metals

It has generally been assumed that a good file is good for all classes of work, brass, cast iron or steel. Some difference of opinion on this subject has been expressed, and there has been a fairly general agreement that a file for brass should have the "up-cut" nearly at right angles to the axis, although this is by no means a general rule. In view of this a series of experiments was planned to ascertain whether there is one particular cut which is best for all metals, or whether each metal requires a special cut to produce the best results. For these tests a number of files were ordered from several makers who were asked to cut them in the manner which they considered most suitable for cast iron, steel, brass, and general work, respectively, each maker supplying a number of files for each purpose.

In the experiments each file was tested on brass, cast iron, mild steel, annealed tool steel and "normalized" tool steel, the last being subjected to heat treatment which would make it uniform in hardness throughout its length without actually annealing it. In one case a brass file gave the best result on brass, but this was the only instance where the best result on any metal was obtained by the file intended for that metal. On the test on cast iron, for instance, two files intended for steel cut more than three times as fast as the files intended for cast iron. On the "normalized" tool steel (not annealed) the cast iron file gave best results. The conclusions of these tests, therefore, showed:

1. The subject of files for specific purposes has practically received no thorough attention. As a rule, files cut for specific purposes gave poor results on the materials for which they were intended, and good results on materials for which they were not intended.

2. Files especially well adapted for any one metal did not give good results on other metals.

3. Files which showed average efficiency on all metals were rather inefficient on all.

4. The tests clearly show that the ductile metals, such as mild or annealed steel, are most easily worked with a sloping cut, which usually produces curled filings. Cast iron and hard brass require a much less sloping cut. Brass files, in fact, should have an "up-cut" almost at right angles to the axis of the file.

5. As a general conclusion, therefore, it appears that it would be advantageous to have files especially cut for various metals and keep them on the work for which they are intended. Most files intended to cut all metals are decidedly inefficient on them all.

It will rest with the user to make the first move in the matter. The file-maker is naturally reluctant to double or triple his stock and to make files for all the existing sizes, shapes and cuts in two or three distinct styles, suited to different metals. The difficulty may involve a slight increase in the price of files, but the increase in efficiency will be out of all proportion to the increase in cost.

Another evidence of the un-uniformity of files and the incomplete understanding of the subject, even by file-makers, is shown by the fact that sometimes files of two or three different qualities are sold by the same maker at different prices. In most, though not in all, cases where such files were tested, it was found that the cheapest grade gave the best result, and the most expensive the worst. This is probably explained by the fact that by a "good" file, the file-maker almost invariably means simply a file of expensive steel.

Most of the leading British file-makers are now investigating, with the aid of the testing machine, the various problems connected with file efficiency. This investigation is attended with special difficulty. Apart from the quality of the steel there are at least eleven important factors, all having an influence on efficiency: seven angles, the sharpness of the chisel, the force of the blow, the coarseness of the cut, and the ratio between the two cuts. It is possible to make an infinite number of combinations of these eleven variables, and an alteration in any one of them is likely to affect several of the others. The problem is, therefore, greatly simplified if a simple file tooth can be isolated and its cutting efficiency measured under constant conditions while progressive changes are made in its shape and in the angle of its presentation to the work.

A Tool Steel Testing Machine

The simplification of the problem mentioned is made possible by the use of a recently-designed tool steel testing machine.

The principle of the tool steel testing machine will be understood from the diagram, Fig. 6, in which *A* represents a tube of steel or other metal, suitably guided and rotating about a vertical axis, while its lower end rests on a fixed abutment *B*. A cutting tool *C* is held in a vise *D*. The vise is mounted on knife edges *E*, lying in the plane of the end of the tube. By means of a screw *F*, with a movable weight and scale, the tool can be caused to press upwards against the edge of the tube with any desired force, and cut it away with a turning action.

The tube is held in contact with the abutment *B* by means of a weight *G*, the downward pressure of which is always greater than the upward pressure of the tool. As the tube is turned away by the tool, it is fed downwards by the weight *G*, so that the end of the tube, though it is constantly being turned away, is constantly held in contact with the abutment *B*, and the point at which cutting takes place is therefore

stationary. A dashpot *H* is connected to the vise to prevent jarring or vibration.

Turning now to the illustration of the machine in Fig. 7, it will be seen that the tube is driven by a spindle, which receives its motion through cone and friction disk gearing, capable of giving it a wide and continuous range of speeds. A paper-covered drum, mounted beside the column of the machine, is driven from the spindle through worm and spur speed reducing gear. Vertical movements of the spindle are communicated through a fine chain to a pencil mounted on a vertical sliding bar.

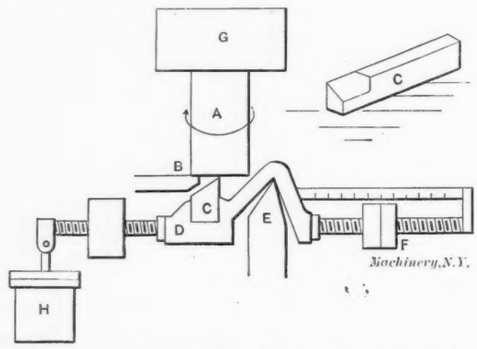

Fig. 6. Diagrammatical View of Action of Tool Steel Testing Machine

When the machine is set in motion, the pencil draws a diagram, in which horizontal distances represent the number of revolutions made by the tube, and vertical distances represent vertical movements of the spindle—*i. e.*, the length of tube turned off by the tool. The slope of the line at any point represents the rate at which the tube is being turned away, which is conveniently expressed in inches per 1,000 revolutions. In practice the tube is ¾ inch diameter and ⅝ inch bore.

By means of this machine it will be possible to ascertain what is the theoretically correct shape for a single file tooth for any particular metal. This information having been obtained, it will rest with the file-maker to ascertain by means of the file-testing machine what combination of theoretically correct file teeth gives the best maximum efficiency and durability to the file.

In the machine shown, the cutting of metal is reduced to its simplest and most elementary form. A straight cutting edge is pressed with a known force against a metal surface of constant width and unvarying hardness, moving at known constant speed, and being cut away at a rate which is graphically recorded. It is evident that the tool continues to cut until it reaches a definite degree of bluntness, when the pressure against the teeth will be insufficient to cause it to penetrate the metal. At this moment it will slip over the surface without cutting, and on the diagram this condition will be shown by the curve becoming horizontal.

Results of Experiments with Tool Steel Testing Machine

The results of these experiments are not, as yet, definite, but so far the results serve to show the character of the information that may be expected, and its bearing on the file tests. A series of tests made to ascertain the effect of variations in the clearance angle or slope of the back of the file teeth, with the front without rake, confirmed in a striking manner the condition that mere sharpness is relatively an unimportant factor in file efficiency. A second conclusion to be drawn from the tests is that the clearance angle has very little influence on the rate of cutting. The most striking feature of the tests is, however, the great difference in the duration and in the total amount of metal removed, showing that 0.05 cubic inch could be cut away with 5 degrees clearance in 100 revolutions before the tool ceased cutting, against 3.7 cubic inches of metal removed in 3,800 revolutions with 25 degrees clearance. Considering that all these tests were made with the same tool, the conclusion previously arrived at that durability of the file and the amount of work it is capable of doing depends far more on the shape of the teeth than on the quality of the steel is confirmed, and it would appear that the chief factor influencing the durability and output is the clearance angle or slope of the back of the teeth. The tests, however, indicate that there is a limit beyond which the clearance angle cannot be increased with advantage. When the clearance angle was greater than 25 degrees, the output and durability began to decrease. This was due to the fact that the edge of the tool broke away, indicating that the tooth was too weak; but it must not, therefore, be assumed that a clearance of 25 degrees is a practical limit. The tests were made with a pressure of 25 pounds, and this pressure applied to a single file tooth probably represents usage more severe than a file would be subjected to.

The results obtained also indicate how files of superior steel may give poorer results than files of inferior steel. In the case above, a tool of the same quality of steel removed in one case seventy-four times as much metal as in another case, the difference being merely a difference in clearance angle. Now it is a well-known fact that a high-carbon steel is much less ductile than one of less hardness. Consequently the high-carbon steel does not flow so readily when struck with a chisel; the burr which forms the working part of every file tooth is much lower, or in other words, the clearance angle is less. Thus it may easily happen that the extra durability of the steel is far more than counteracted by the lack of clearance, and a file of very good steel may give exceedingly poor results as a cutting tool if not properly cut with a clear understanding of the requirements of the durability and efficiency of files.

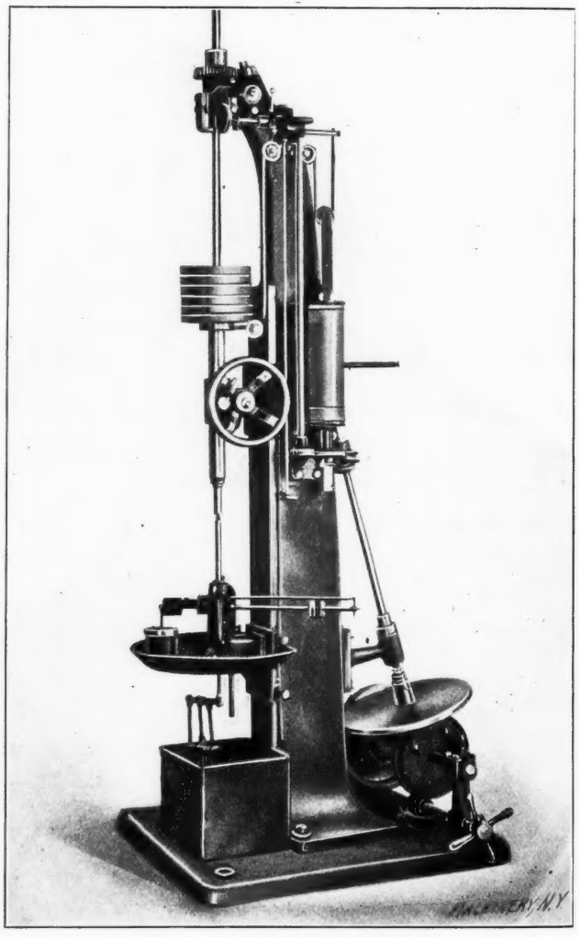

Fig. 7. Tool Steel Testing Machine

A series of experiments was made with a view to ascertaining the effect of varying degrees of rake and slope on the efficiency and durability of file teeth, the term slope being used to indicate the angle at which the up-cut lies across the face of the file. Only two slopes were experimented with —a slope of 90 degrees, corresponding to the cut of a file intended for brass, and a slope of 70 degrees, such as is commonly found in files intended for general work.

Each of these slopes was tested in conjunction with three different degrees of rake, *viz.*, a negative rake of 15 degrees, as commonly found in file teeth; a zero rake, the front face of the tooth standing at right angles to the surface of the work, a condition occasionally approached in file teeth; and a positive or forward rake of 15 degrees, a condition which is never found in file teeth, though experience with other cutting tools points to this as the correct form for cutting most metals. The same tool was used throughout, so as to eliminate any variations due to difference of temper or quality in the steel. Each test was made with a freshly sharpened edge, and was continued until cutting ceased. The pressure of the tool on the work was in all cases 25 pounds, the cutting speed 30 feet per minute, and the clearance angle of the tool 20 degrees in all except two of the tests.

The results of these tests showed that an extraordinary difference in the output of the work can be obtained in the same tool by a relatively slight variation in its cutting angles. Contrary to what might be expected, these variations have much greater effect on the output than on the rate of cutting. It was also noticed in these, as in all other tests made with the machine, that mere keenness of edge had very little effect on the efficiency. All the curves obtained were approximately straight lines, and cutting ceased abruptly with very little previous loss of efficiency.

Conclusions of Tests Relating to Shape of File Teeth

In relation to commercial file-making, the most important conclusion of the tests appears to be that the least desirable results of all were obtained with the tool which most closely resembled the commercial file tooth. The best results of all were obtained with a form of tooth which can probably be reproduced without great difficulty, but which appears never to have been adopted. This tooth would have a positive front rake of 15 degrees, and a clearance of 5 degrees. It was previously shown that the clearance angle is a most important factor in determining the total output and that the tool with no rake and only 5 degrees clearance will do only a very small amount of work, but it appears that a tool with the same clearance angle and with positive front rake will do an exceptionally large amount of work with great efficiency, and it is probable that by slightly increasing the clearance angle the output will be still further increased without undue weakening of the cutting edge.

Some caution will, of course, be necessary in applying the results just described to the art of file-making. These tests were made with what was practically a single isolated file tooth with a straight instead of a rounded cutting edge. The file is a series of round-nosed tools, lying very close together, and it may be found that a file with a positive rake will have a tendency to choke up with filings to such an extent as to neutralize its greater efficiency. The progress must be made by systematic experiments, confirmed at every step by the file-testing machine.

The results first described have a bearing on other cutting tools besides files. Of all the tool forms experimented with, among those that gave the smallest output of work was one having no front rake. This, however, is the usual form of tooth for milling cutters. There seems to be no reason for making milling cutters without front rake, except the well-known propensity of human beings to follow in their forefathers' footsteps. Milling cutters with front rake have been made and tried, and have given good results, and yet it is impossible to buy such cutters without having them made to order.

The Testing of Tool Steel

We now pass to the consideration of that function of the tool steel testing machine from which it derives its name and which may prove to be of greater practical importance than any other—the testing of the quality of tool steel. The slope of the curves produced on the diagram in the testing machine indicate the rate at which the test tube is being cut away by the tool point, and it is evident that this rate is governed by several factors: the speed and quality of the test tube, the shape and position of the tool, and the force with which it is pressed against the tube. Any alteration in any one of these factors will affect the rate of cutting and the slope of the curve, which therefore serves as an absolute check on the uniformity of the mechanical conditions. The remaining factor in the test is the quality of the steel, and a moment's consideration will show that this does not affect the rate of cutting at all. So long as a number of tools are equally sharp, they will all cut at the same rate under the same conditions, no matter what steel they are made of; but the tool which is made of the best steel will remain sharp longest.

The results of experiments on carbon steel and high-speed steel are shown in Figs. 8 and 9. At slow speed (30 feet per minute) the carbon steel lasted four times as long as the high-speed steel. At a somewhat higher speed (40 feet per minute), the high-speed steel tool lasted twice as long as the carbon steel. These tests were repeated, but the same results were obtained. Up to a certain limit all tools with increased speed not only did more work per unit of time, but lasted a greater number of revolutions. Another interesting experiment was carried out with a blunt tool. It was tested until it ceased cutting at 40 feet per minute; when the speed was increased to 85 feet per minute the same tool immediately began cutting faster, that is, removing more metal per revolution than when it was quite sharp and working at a lower speed. This indicates that there is a definite state of bluntness corresponding to each speed. These are a few of the many curious facts that have been brought into prominence by the tool steel testing machine. They may or may not have an important bearing on the art of cutting metals, but it is necessary to bear them in mind.

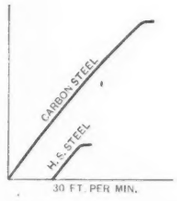

Fig. 8. Comparison of Durability of Carbon and High-Speed Steels at Low Cutting Speed

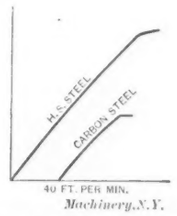

Fig. 9. Comparison of Durability of Same Steels at Increased Cutting Speed

The conclusions also throw an interesting light on the relative value of ordinary carbon and high-speed steels for various tools. For files, for instance, having a low cutting speed, it is likely that special alloy steels are of but little value. While it may not be assumed that all alloy steels are inferior to carbon steel for file making, it is evidently unsafe to assume that because a certain steel has given good results, say, for twist drills, it would be suitable for cutting tools used under totally different conditions. For instance, reamers are generally used for a slight scraping cut at a low speed, precisely under conditions for which high-speed steel seems to be least suited, and for such tools the high quality steel appears to be unwarranted. It may be too soon to dogmatize, but there seems to be reason for caution in the application of high-speed steel to the manufacture of such tools as reamers and milling cutters for light finishing work.

Another experiment showed that the maximum duty could be obtained from a carbon steel at the cutting speed of 50 feet, by a good high-speed steel at 85 feet, and from one of the new British high-speed steels at 140 feet per minute cutting mild steel. This latter result was unexpected, since no increase in the working speed was claimed by the makers of the new steel, but only an increase of durability at the speeds at which high-speed steel is ordinarily used. The tool steel testing machine can also be used for ascertaining the wear of metals, the efficiency of the various lubricants in cutting operations to preserve the edge of the tool, and for testing the hardness of metals.

The testing for hardness is accomplished by a drill loaded with a certain weight, and the rate at which it penetrates the material under investigation is used as a measure of hardness. This test is by no means new, but it has often been regarded with some distrust, because the sharpness of the drill is a variable factor in the result of the test as ordinarily applied. The production of considerable quantities of

test bars for the file and steel testing machines has called for some accurate method of judging hardness (using that rather vague term to denote resistance to the action of cutting tools), and the drill test has proved itself during nearly two years of continuous use the most sensitive and reliable test available.

The distributing influence of the varying sharpness of the drill is eliminated by adopting a definite rate of penetration on a standard reference bar. Suppose the rate of penetration of half an inch per 1,000 revolutions to be adopted, the load on the drill is adjusted until this rate of penetration is obtained on the standard bar. Tests on the materials under investigation are then made, and any variation in the rate of penetration, beyond certain predetermined limits, leads to the rejection of the material. Periodically a return is made to the standard bar, and any loss of penetration due to blunting of the drill is corrected by increasing the load. In practice a considerable number of tests can be made on ordinary materials without perceptible blunting of the drill. The sensitiveness of the test depends entirely on the rate of penetration adopted. A drill so lightly loaded as to be on the point of slipping gives a hardness test which is probably more sensitive than any other. In this connection it is interesting to note that drills of high-speed steel have proved quite unsuitable for the drill test, as they lose their sharpness much more rapidly than drills of carbon steel, under the extremely light cuts that are essential for a sensitive test.

The results put forward in the foregoing have been confirmed by repeated experiments, and are believed to be reliable as far as they go, but important facts may be undiscovered and those phenomena which have come into view may be only parts of larger phenomena which cannot be seen in their true perspective until they have been investigated from every side, and under widely varied conditions of experiment.

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SIZES OF PIPE MAINS FOR HOT WATER HEATING*†

CHARLES L. HUBBARD‡

In the accompanying Supplement three sets of curves are given for determining the sizes of pipe mains for hot water heating. Two of the diagrams are for gravity circulation where the water is moved under a low head, the motion being due solely to the difference in temperature between the supply and return. The third diagram is made up for the usual range of velocity and head employed in forced hot water circulation actuated by means of a pump. In all cases the capacities are for pipe lengths of one hundred feet.

Volume of Water to be Moved

The volume of water to be passed through the supply main in a heating system may be found by the following equation:

$$G = \frac{E \times H}{8.3 \times (T - T_1)}$$

in which G = gallons per hour,

E = efficiency of radiating surface (170 for direct, 400 for indirect, and 1,000 for hot blast heating),

H = square feet of heating surface,

T = initial temperature of water (commonly taken as 180 degrees),

T_1 = final temperature of water (commonly taken as 160 degrees).

Example.—A heating system has 5,000 square feet of direct heating surface, and 1,000 of indirect; how many gallons of water (G_1) must pass through the main per minute, assuming a drop in temperature of 20 degrees?

$$G_1 = \frac{(170 \times 5{,}000) + (400 \times 1{,}000)}{8.3 \times 20 \times 60} = 125 \text{ gallons.}$$

* For additional information relating to heating and ventilation, see the following articles previously published in MACHINERY: Calculations of Fans and Heaters, June, 1908, engineering edition; The Heating and Ventilation of Machine Shops, September, 1907, engineering edition; and also the articles referred to in connection with the one last mentioned. See also MACHINERY'S Reference Series No. 39: Fans, Ventilation and Heating.

† With Data Sheet Supplement.

‡ Address: 283 Central St., Auburndale, Mass.

Head to Produce Flow

The head to produce flow may be found by the equation

$$H = D \times h\ 0.000365.$$

in which

H = head in feet, producing flow,

D = difference in temperature between supply and return,

h = height or elevation of the heating surface above the boiler.

Example.—A certain quantity of heating surface is located at an elevation of 50 feet above the boiler; what is the available head for producing flow through the supply riser if the drop in temperature between the supply and return is 30 degrees?

$$H = 30 \times 50 \times 0.000365 = 0.55 \text{ feet.}$$

When the radiation is all on the same floor, the elevation h may be taken as the vertical distance between the center of the radiators and the center of the boiler. If it is equally distributed on several floors it may be taken as though it were all located upon the central floor.

If unevenly distributed, the *average elevation* may be found by the equation

$$h = \frac{A \times h_a + B \times h_b + C \times h_c}{A + B + C}$$

in which A, B, and C are the square feet of radiation upon the several floors, and h_a, h_b, and h_c the corresponding elevations of the radiators located upon these floors.

In computing the length of mains, provision must be made for the frictional resistance due to bends in the pipe. In practice it is customary to consider an elbow equivalent to increasing the length of the pipe 60 diameters, and a return bend equivalent to 120 diameters.

The size of main required to supply a heating system or group of heaters depends upon the square feet of radiation, the elevation above the boiler, the drop in temperature of the water in passing through the radiators, and the length of run. Taking the examples previously given, and assuming the length of the mains to be 200 feet, what size of pipe will be required?

Gallons per minute 125; available head to produce flow 0.55 foot. As the run of pipe is 200 feet long, the head per hundred feet is $\frac{0.55}{2} = 0.27$ foot. From diagram II in the Supplement we find that a flow of 125 gallons under a head of 0.27 foot calls for a pipe between 5 and 6 inches in diameter, in which case the larger size would probably be used.

Forced Circulation

In case of forced circulation the mains should be of such size that the total head required to overcome the friction will not exceed 50 feet, the usual range being from 30 to 50 feet. The velocity of flow is usually made from 5 feet per second in the smaller sizes (2 to 3 inches) to 10 feet per second in the larger sizes (6 to 8 inches).

The table in the Supplement gives the capacity of different sizes of pipe for varying velocities of flow through them.

* * *

In spite of their conservatism and proverbial "slowness," our British friends have achieved remarkable results in the running of fast trains, and on the Great Western R. R. results are obtained which are not equalled by any regular American service. Between London and Exeter, a distance of 174 miles, three expresses run daily without a stop, in exactly three hours, or at an average speed of 58 miles an hour. A fourth train on the same route makes the same run at an average speed of 56.3 miles per hour. It is not unusual for the total load back of the tender of these trains to be 400 tons.

* * *

The new radium institute of Great Britain has placed an order for a trifle over one-quarter of an ounce of radium-bromide, the price for which is not less than $150,000, or at the rate of $570,000 per ounce, or over $9,000,000 per pound. Some conception of the enormous labor involved in the extraction of this mineral is afforded by considering the price of a pound given as the wages of 15,000 men working one year of 300 working days at $2.00 per day.

THE COMMERCIAL AIRSHIP—A CRITICISM

FORREST E. CARDULLO*

In an article entitled "The Commercial Airship," in the August issue of MACHINERY, Mr. McCready reviews briefly the disadvantages of the heavier-than-air machines, and of the gas-inflated airships, stating that both are impractical for commercial work. As a substitute for them, Mr. McCready proposes a type of airship consisting in principle of a metallic reservoir of large volume from which air can be exhausted, lightening it by the weight of the air so exhausted. Obviously, if this contrivance is to be successful, the weight of the metal envelope must be less than that of the displaced air, and since the reservoir is to be exhausted of air, it must be strong enough to resist the external air pressure, which is 14.7 pounds per square inch or 2,117 pounds per square foot.

Now it follows that the material to use in the construction of this airship is that which has the greatest strength for a given weight. This material will be one of the alloy steels having high elastic limit and tensile strength. Aluminum is lighter, but is also weaker in much greater proportion. Many alloys of low specific gravity present advantages in certain types of construction, but pound for pound, they are not as strong as the alloy steels. Such alloy steels weigh about 480 pounds per cubic foot.

The form of reservoir which contains the largest volume within a given bounding area is the sphere. Consequently for a given volume and thickness of wall, a sphere will make the lightest reservoir. Also, since the compressive stress is the same in every cross section of the wall cut by a radial plane, the sphere will have the thinnest wall of any shape of the same diameter. It is apparent, then, that no lighter construction could be made than a perfect sphere without bracing. If the sphere is perfect, and the external pressure uniform, bracing is theoretically unnecessary, and no possible system of bracing can be devised which would make a sphere stronger for the same weight, than its theoretical strength, calculated on the assumption that it is perfect in form, homogeneous in material, and subjected to a uniform pressure. Hence if a spherical reservoir cannot be made light enough and strong enough to perform the desired service, no other form of reservoir will be possible.

Volume of 1 pound of air at 62 degrees F. and 14.7 pounds pressure per square inch = 13.141 cubic feet.

Volume of a sphere $= 0.5236\ d^3$.

Area of a sphere $= 3.1416\ d^2$.

Area of its great circle $= 0.7854\ d^2$.

Circumference of its great circle $= \pi\ d$.

Diameter of a sphere having a displacement of 1 pound of air at 62 degrees F. at sea level = 2.93 feet, which is found as follows:

$$13.141 = 0.5236\ d^3$$

$$d = \sqrt[3]{\frac{13.141}{0.5236}} = 2.93.$$

Its area will then be

$$3.1416 \times 2.93^2 = 26.97 \text{ square feet.}$$

Assuming that the steel weighs 480 pounds per cubic foot, and further that the shell will weigh exactly one pound, we find for the thickness of the shell

$$\frac{1}{26.97 \times 480} = 0.0000772 \text{ foot.}$$

or $0.0000772 \times 12 = 0.000926$ inch, or the thickness of our shell will be a trifle less than one-thousandth part of an inch.

The area of the great circle of this sphere will be

$$0.7854 \times 2.93^2 = 6.74 \text{ square feet,}$$

and the pressure upon it, at 14.7 pounds per square inch, is

$$6.74 \times 14.7 \times 144 = 14{,}270 \text{ pounds.}$$

The circumference of the great circle is

$$3.1416 \times 2.93 = 9.205 \text{ feet or } 110.5 \text{ inches.}$$

It therefore follows that the cross section of the shell on the great circle is $110.5 \times 0.000926 = 0.1023$ square inch.

The compressive stress produced in this cross section by the pressure of the air is therefore

$$\frac{14{,}270}{0.1023} = 140{,}000 \text{ pounds per square inch.}$$

Now it is obvious that we have hardly any substance sufficiently strong to construct such a sphere, and certainly there is no substance sufficiently strong to construct a sphere able to float in air and in addition lift 55 per cent of its own weight, when interior bracing is added to prevent collapse.

Mr. McCready states in his article that the vacuum system becomes proportionately more practicable and efficient as the size of the airship is increased. Let us see if this is true.

$$\text{Stress} = \frac{\text{pressure on great circle}}{\text{cross section at great circle}} = \frac{0.7854\ d^2 \times 14.7 \times 144}{3.1416\ d\ t} = \frac{529\ d}{t}.$$

$$\text{Weight of 1 cubic foot of air} = \frac{1}{13.141} \text{ pound.}$$

$$\text{Volume of } \frac{1}{13.141} \text{ pound of steel} = \frac{1}{13.141 \times 480} = 0.0001585$$

cubic foot.

Cubic feet of steel in shell $= 0.0001585 \times 0.5236\ d^2$.

Area of shell $= 3.1416\ d^2$.

$$\text{Thickness of shell} = t = \frac{0.0001585 \times 0.5236\ d^2}{3.1416\ d^2} = 0.000026\ d.$$

or the stress $= \dfrac{529\ d}{0.000026\ d} = 20{,}300{,}000$ pounds per square foot, and is independent of the diameter.

One point alone in regard to the construction advocated in the article referred to will serve to show its futility. The figures for a proposed vacuum airship are given as 150 feet diameter by 750 feet long. The weight of the cylinder, fittings and machinery is given at 270 tons. *If all of this 270 tons were utilized as a 700-foot steel column, keeping the ends of the cylinder apart against atmospheric pressure, the stress in the column would be 163,000 pounds per square inch.*

The truth of the above assertion may be demonstrated as follows: The area of a circle 150 feet in diameter is 17,671 square feet. On each square foot there will be a pressure of 2,117 pounds, or a total compressive stress, tending to force the ends together, of 37,400,000 pounds. Assuming the column to weigh 270 tons, or 540,000 pounds, its volume will be 1,125 cubic feet, and if it is 700 feet long, allowing for the conical ends, its cross section will be 1.6 square foot or 230 square inches. Now the stress in the column $= \dfrac{37{,}400{,}000}{230} =$ 163,000 pounds per square inch.

This stress looks rather excessive in a column 700 feet long. The following figures in regard to the stress in the walls, normal to an axial plane are, however, even more illuminating.

The strongest and lightest construction that we know of in the case of a cylinder subjected to external pressure, is that used in the Morrison corrugated furnace. The reason it is so strong is that the cylinder wall furnishes its own bracing. Let us suppose that the airship is built on this principle, and that the whole 270 tons is put into self-bracing wall. Then, the weight of cylinder wall per foot of length will be $\dfrac{540{,}000}{700} = 771$ pounds. This 771 pounds of metal will form a band around the cylinder $150\ \pi = 471$ feet long, and its volume, if of steel, will be $\dfrac{771}{480} = 1.6$ cubic foot. Its cross-section will then be $\dfrac{1.6 \times 144}{471} = 0.5$ square inch

The total stress in this band will be one-half the pressure of the air upon 150 square feet (*i. e.*, the area of the projection of a section of the cylinder one foot long upon the axial plane) which is $\dfrac{150 \times 14.7 \times 144}{2}$ or 159,000 pounds. The stress per square inch is then $\dfrac{159{,}000}{0.5}$ or 318,000 pounds.

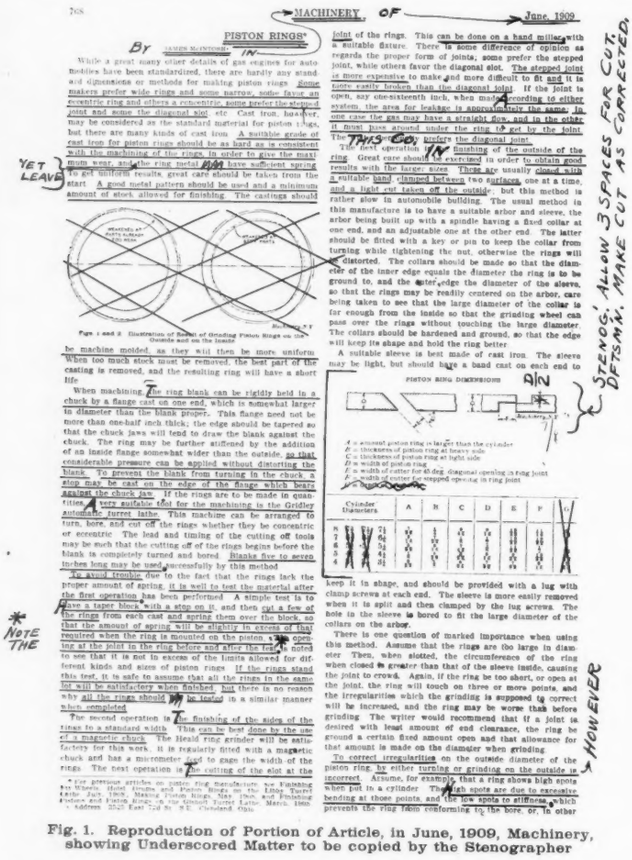
We are forced to the conclusion that no ingenuity of construction will make such an airship able to support even its own weight, unless we construct it of some unknown material having a strength many times greater weight for weight, than that of the strongest steel.

* Address: New Hampshire State College, Durham, N. H.

BUSY MAN'S METHOD OF KEEPING A NOTE-BOOK*

JOHN S. MYERS†

Ideas unapplied to a useful purpose are worthless. A man's mind may be as full of ideas as a dog's fur of fleas and yet the man derive no more benefit from those ideas than the dog does from the fleas. Now the more busy the individual, the greater the number of ideas which crowd around the court of judgment crying for deliverance, and the greater the number of other people's ideas that are recognized as good; yet, at the same time, from the very nature of the case, the less time the individual has to devote to the useful


MACHINERY, OF June, 1909

PISTON RINGS*

By ... IN

While a great many other details of gas engines for automobiles have been standardized, there are hardly any standard dimensions or methods for making piston rings. Some makers prefer wide rings and some narrow, some favor an eccentric ring and others a concentric, some prefer the stepped joint and some the diagonal slot, etc. Cast iron, however, may be considered as the standard material for piston rings, but there are many kinds of cast iron. A suitable grade of cast iron for piston rings should be as hard as is consistent with the machining of the rings, in order to give the maximum wear, and while ring metal must have sufficient spring to get uniform results, great care should be taken from the start. A good metal pattern should be used and a minimum amount of stock allowed for finishing. The castings should be machine molded, as they will then be more uniform. When too much stock must be removed, the best part of the casting is removed, and the resulting ring will have a short life.

When machining, the ring blank can be rigidly held in a chuck by a flange cast on one end, which is somewhat larger in diameter than the blank proper. This flange need not be more than one-half inch thick; the edge should be tapered so that the chuck jaws will tend to draw the blank against the chuck. The ring may be further stiffened by the addition of an inside flange somewhat wider than the outside, so that considerable pressure can be applied without distorting the blank. To prevent the blank from turning in the chuck a stop may be cast on the edge of the flange which bears against the chuck jaw. If the rings are to be made in quantities, a turret lathe is very suitable for the machining is the Gridley automatic turret lathe. This machine can be arranged to turn, bore, and cut off the rings whether they be concentric or eccentric. The lead and timing of the cutting off tools may be such that the cutting off of the rings begins before the blank is completely turned and bored. Blanks five to seven inches long may be used successfully by this method.

To avoid trouble due to the fact that the rings lack the proper amount of spring, it is well to test the material after the first operation has been performed. A simple test is to have a taper block with a stop on it, and then cut a few of the rings from each cast and spring them over the block, so that the amount of spring will be slightly in excess of that required when the ring is mounted on the piston. The opening at the joint in the ring before and after the test is noted to see that it is not in excess of the limits allowed for different kinds and sizes of piston rings. If the rings stand this test, it is safe to assume that all the rings in the same lot will be satisfactory when finished; but there is no reason why all the rings should not be tested in a similar manner when completed.

The second operation is the finishing of the sides of the rings to a standard width. This can be best done by the use of a magnetic chuck. The Heald ring grinder will be satisfactory for this work. It is regularly fitted with a magnetic chuck and has a micrometer head to gage the width of the rings. The next operation is the cutting of the slot at the joint of the rings. This can be done on a hand miller with a suitable fixture. There is some difference of opinion as regards the proper form of joints; some prefer the stepped joint, while others favor the diagonal slot. The stepped joint is more expensive to make and more difficult to fit and it is more easily broken than the diagonal joint. If the joint is open, say one-sixteenth inch, when made according to either system, the area for leakage is approximately the same; in one case the gas may have a straight flow, and in the other it must pass around under the ring to get by the joint. This company prefers the diagonal joint.

The next operation is the finishing of the outside of the ring. Great care should be exercised in order to obtain good results with the larger sizes. These are usually closed with a suitable band clamped between two surfaces, one at a time, and a light cut taken off the outside; but this method is rather slow in automobile building. The usual method in this manufacture is to have a suitable arbor and sleeve, the arbor being built up with a spindle having a fixed collar at one end, and an adjustable one at the other end. The latter should be fitted with a key or pin to keep the collar from turning while tightening the nut, otherwise the rings will be distorted. The collars should be made so that the diameter of the inner edge equals the diameter the ring is to be ground to, and the outer edge the diameter of the sleeve, so that the rings may be readily centered on the arbor, care being taken to see that the large diameter of the collar is far enough from the inside so that the grinding wheel can pass over the rings without touching the large diameter. The collars should be hardened and ground, so that the edge will keep its shape and hold the ring better.

A suitable sleeve is best made of cast iron. The sleeve may be light, but should have a band cast on each end to keep it in shape, and should be provided with a lug with clamp screws at each end. The sleeve is more easily removed when it is split and then clamped by the lug screws. The hole in the sleeve is bored to fit the large diameter of the collars on the arbor.

There is one question of marked importance when using this method. Assume that the rings are too large in diameter. Then, when slotted, the circumference of the ring when closed is greater than that of the sleeve inside, causing the joint to crowd. Again, if the ring be too short, or open at the joint, the ring will touch on three or more points, and the irregularities which the grinding is supposed to correct will be increased, and the ring may be worse than before grinding. The writer would recommend that if a joint is desired with least amount of end clearance, the ring be ground a certain fixed amount open and that allowance for that amount is made on the diameter when grinding.

To correct irregularities on the outside diameter of the piston ring by either turning or grinding on the outside is incorrect. Assume, for example, that a ring shows high spots when put in a cylinder. The high spots are due to excessive bending at those points, and the low spots to stiffness, which prevents the ring from conforming to the bore, or, in other

Fig. 1. Reproduction of Portion of Article, in June, 1909, Machinery, showing Underscored Matter to be copied by the Stenographer

application of those ideas. Nevertheless, if you have an idea to develop do not take it to a man of leisure, for he will not have time to consider it, but take it to the busiest man you know and you will find he can and will take time to pronounce judgment thereon.

Now, in the matter of note-books, the chief draftsman of a concern should be the man best fitted for the compilation of all matter of a mechanical or constructive nature, but, at the same time, he is the one man whose mind is already burdened with excessive detail; how, then, is he to do anything in this line? The answer obviously lies in the proper direction of efficient help.

The writer once worked for a large concern that employed a librarian; the librarian had charge of the vaults, storage and recording of all drawings, correspondence, trade literature, etc. It was the duty of the assistant librarian to conscientiously peruse all the trade magazines, catalogues, etc., in search of salient or pertinent information, and all such was clipped, pasted to cards, referred to the proper officer of the company and afterwards carefully filed. The magazines were all subscribed for in duplicate so that there was always an unmutilated copy on file to refer to for the complete text of an article any clipping was made from.

But most concerns would not care to go into the matter so extensively, and even those who could and would might find, as the writer did, many mountains in the way of best results. I therefore take pleasure in presenting to the readers of MACHINERY an inexpensive scheme for the busy man to compile a note-book in neat form with the minimum expenditure of his time and nervous energy.

The scheme as outlined is for the *very busy man;* for those who have more time to devote to it I would suggest that they simply do more of the work themselves and leave less to their help.

1. Direct that all magazines, catalogues, etc., be left on your desk as received.
2. Glance through each as received and mark or note any article of promise which you think may contain matter of especial interest to your line of work.
3. After so marking, throw the magazine or article in a box or drawer especially devoted to the purpose.
4. If the concern is very large have several of these boxes or drawers labeled *Mechanical, Structural, Electrical,* or any other classification that may suit your commercial conditions.
5. Instruct your squad bosses or specialists in various lines to dispose of the material in the following manner:
7. Squad foreman will at stated or convenient intervals go over all matter in his box or folder and carefully read all marked articles, and if he finds matter worthy of noting he will underscore the salient or pertinent matter with such corrections, notes, etc., as will enable a stenographer to transcribe same in a condensed form.
8. The stenographer will typewrite the underscored matter on standard loose leaf note-book paper, using a black ribbon and a sheet of carbon paper *reversed,* so that blue prints may be made.
9. The squad foreman will read over such transcribed matter and make any necessary corrections.

PISTON RINGS

By James McIntosh in MACHINERY for June 1909.

Some makers prefer wide rings and some narrow, some favor an eccentric ring and others a concentric, some prefer the stepped joint and some the diagonal slot. A suitable grade of cast iron for piston rings should be as hard as is consistent with the machining of the rings, in order to give the maximum wear, and yet leave the ring metal with sufficient spring. A good metal pattern should be used and a minimum amount of stock allowed for finishing. The castings should be machine molded, as they will then be more uniform.

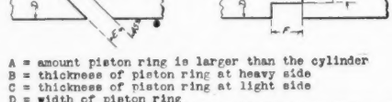
The ring blank can be rigidly held in a chuck by a flange cast on one end, so that considerable pressure can be applied without distorting the blank. To prevent the blank from turning in the chuck, a stop may be cast on the edge of the flange which bears against the chuck jaw. A very suitable tool for the machining is the Gridley automatic turret lathe. Blanks five and seven inches long may be used.

To avoid trouble it is well to test the material after the first operation. Have a taper block with a stop on it, cut a few of the rings, and spring them over the block, so that the amount of spring will be slightly in excess of that required when the ring is mounted on the piston. Note the opening at the joint in the ring before and after the test. If the rings stand this test it is safe to assume that all the rings in the same lot will be satisfactory when finished; but all the rings should be tested when completed.

The finishing of the sides of the rings to a standard width can be done by the use of a magnetic chuck. The cutting of the slot at the joint can be done on a hand miller. The stepped joint is more expensive and is more easily broken than the diagonal joint. According to either system the area for leakage is approximately the same; in one case the gas may have a straight flow, and in the other it must pass around under the ring to get by the joint. This company prefers the diagonal joint.

In finishing the outside of the ring care should be exercised to obtain good results with the larger sizes. These are closed with a band, clamped between surfaces, and a light cut taken off the outside.

PISTON RING DIMENSIONS



A = amount piston ring is larger than the cylinder
B = thickness of piston ring at heavy side
C = thickness of piston ring at light side
D = width of piston ring
E = width of cutter for 45 deg. diagonal opening in ring joint
F = width of cutter for stepped opening in ring joint

Cylinder Diameters	A	B	C	D	E	F
8	7-1/4	7/32	1/4	9/16	15/32	11/16
7	6-1/4	3/16	7/32	1/8	1/2	13/32	19/32
6	5-1/4	5/32	3/16	7/64	3/8	11/32	1/2
5	4-1/4	1/8	5/32	3/32	5/16	9/32	13/32
4	3-1/4	3/32	1/8	5/64	7/32	7/32	5/16

To correct irregularities by turning or grinding on the outside is, however, incorrect. High spots are due to excessive bending at those points, and low spots to stiffness. If we reverse the method and grind on the inside the irregularities will be corrected, for these stiff portions will become weaker and tend to bend more and the stresses in the ring will be equalized.

The table gives piston ring dimensions based on experience. The width D may be increased in wearing surface, but tabulated dimensions give satisfactory results. The inside of the ring should always be machined. The practice of annealing ring blanks does not seem desirable, as stresses due to cooling are remote with a ring blank of uniform thickness.

Fig. 2. Reproduction of Note-book Page, showing the Form in which Condensed Matter appears. Typewritten on Thin Paper with Carbon reversed on Back, thus making Copy that will blue-print well

10. The boy in charge of the note-books will see that blueprints of this matter are inserted in the several note-books kept in the office for general reference, and that special marked copies be delivered to foreman, etc., in charge of work upon which the articles especially bear.

To make the method perfectly clear I have selected at random an article in the June issue of MACHINERY, underlined it as would be done before passing to the stenographer. A reproduction of this underlined and noted article is shown in Fig. 1. In Fig. 2 is shown a reproduction (reduced) of the notes as transcribed by the stenographer.

* For articles previously published in MACHINERY on this subject, see "Envelope System for Filing Data," June, 1906, and "Binder for Preserving Articles of Special Interest," March, 1909.

† Address: 2456 Almond St., Philadelphia, Pa.

SIMPLE AND AUTOMATIC STOP-PINS FOR PRESS WORK

H. A. S. HOWARTH*

The stop-pin occupies a position of much importance among the accessories of the blanking die. Upon its design and adjustment depend both the quality and the quantity of the output of the press. Hence it is fitting that some attention be given to the consideration of it. By proper selection from the types to be described it is possible to secure a large output of blanks without recourse to more expensive apparatus. The several forms of stop-pins enumerated in the following list will be described in order, their proper uses being noted together with their merits and faults: The plain fixed stop-pin; the bridge stop-pin; the simple latch; the spring toe latch; the side swing latch; the positive heel and toe latch; the gang starting device.

These devices are capable of giving under the proper conditions, the maximum output of blanks. With the exception of the first, they can be used with either hand feed or automatic roll feed.

The ideal output of one blank for every turn the press can make in a day is never realized, with single dies. The delays

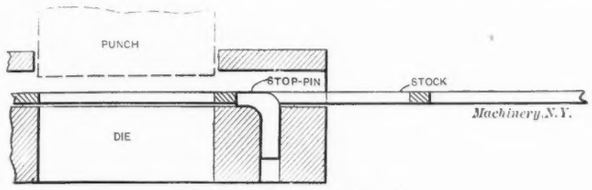


Fig. 1. A Plain Fixed Stop-pin

which arise from so many sources have to be studied carefully and eliminated so far as they contribute to unnecessary expense. In addition to improper design and poor adjustment of the stop-pin, other causes of small output are: Lack of skill; inconvenient arrangement of the new stock, the blanks and the scrap; inefficient methods of oiling the stock; and poorly made or poorly designed dies. A skillful operator, if given a little freedom, will usually arrange the stock distribution quite well, but the design and adjustment of the dies and the stop-pin usually devolves upon the toolmaker.

Plain Fixed Stop-pin

The plain fixed stop-pin, which is the simplest form, is indicated in Fig. 1. With it the operators become so expert that they are able for several minutes at a time to utilize every stroke of a press making 150 revolutions per minute. This stop is best suited to the use of strip stock in simple dies, because a miss will then cause no serious delay. The time between finishing one strip and starting the next affords the necessary rest for the operator. The concentration required is very intense—especially for the novice. When but a few blanks are made from a die at one time, and when changes of dies are frequent, this simple stop-pin is the most economical. Then too, it would not be feasible to use this stop-pin for coiled stock and expect the operator to finish the coil without

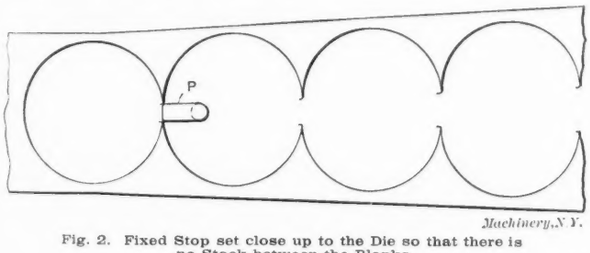


Fig. 2. Fixed Stop set close up to the Die so that there is no Stock between the Blanks

a rest or a miss. There is, however, one method of using this stop which permits of a maximum output: That is to allow no metal between the blanks. Then the stop-pin will extend clear up to the die and be high enough so that the stock cannot jump it. Each blank will then part the scrap at the stop-pin and allow the stock to be pulled along to its next position. This arrangement is shown in Fig. 2, with the stock parting at the pin *P*. This method is widely used on simple work where the edge of the blank does not have to be perfectly uniform. Where the die has least to cut it will wear away most on account of the thin pieces of stock that crowd down between the punch and the die. Small drawn cups are made in this way. The blank is cut by the first punch and held by it while a second punch, within the first, draws the blank through another die and forms the cup. This

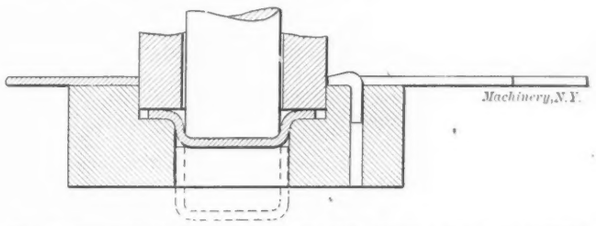


Fig. 3. Example of Work to which the Stop shown in Fig. 2 is adapted

is shown in Fig. 3. The stock feeds to the right and each cup, as formed, pushes the one ahead of it through the die as indicated by the dotted lines.

Bridge Stop-pin

The bridge stop-pin, shown in Fig. 4, is perhaps the most efficient and easiest to operate of all. It is also the simplest in design. The stop-pin *P* projects downward from a bridge *B* that extends over the stock which is being fed to the left. Provision is made for the blank (or scrap, as the case may be) to fall out under the bridge. Its use is limited, however, to that class of work which cuts the stock clear across and uses its edges as part of the finished blank. As here shown, the scrap is being punched through the die and the blank when cut falls down the inclined surface shown. When the

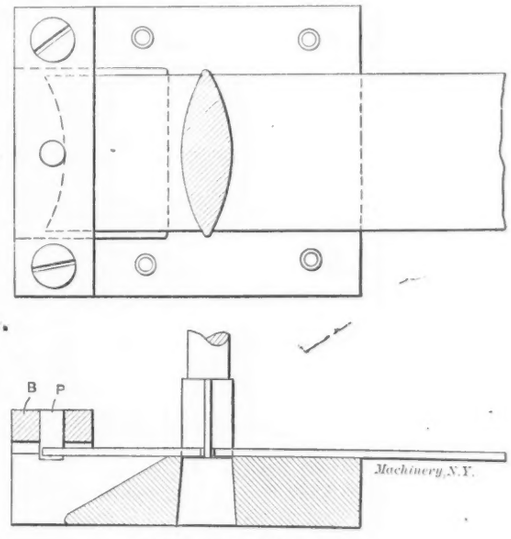


Fig. 4. The Bridge Stop-pin

blanks are simpler and have straight ends the die may be so arranged that each stroke finishes two blanks, one being punched through the die and the other falling outside down the incline. Little skill is required of the operator; he simply has to be sure to push the stock up to the stop-pin each stroke.

The Simple Latch

The simple latch is shown in Fig. 5. It is suited for dies that have pilot-pins. The latch is lifted by the down stroke of the punch and is lowered again as the punch rises. Hence it is evident that, if used with dies without pilot-pins, the punch must reach the stock and hold it before the latch lifts. When its lifting is thus delayed it will lower before the punch withdraws from the stock and will fall in the same place it lifted from. The stock will then not be fed along. But if a pilot-pin is used, it may be set so as to enter the guide hole just before the latch lifts. The latch may be set to lift before the punch reaches the stock. It will then fall after the punch withdraws from the stock, and sufficient time may be allowed for the operator to feed the stock along. This device is best

* Address: Box 174, South Bethlehem, Pa.

suited for use with automatic feed rollers because the timing of the operations would be more uniform; whereas if the operator does not pull the stock with uniform speed the latch is apt to drop too soon or too late. Another manner of operating this simple latch is to give it its motion by means of a

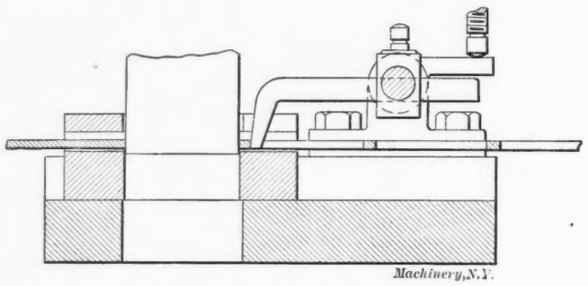


Fig. 5. The Simple Latch Form of Stop

cam or eccentric on the press shaft. When thus driven its motion can be very carefully timed, irrespective of pilot-pins. This style is also best suited for automatic roll feed. New presses are often provided with this attachment.

The Spring Toe Latch

The spring toe latch involves but little change from the simple latch. Fig. 6 shows it clearly with an enlarged detail of the spring toe. This latch may be used very successfully with hand feed and there is little danger of the stock getting

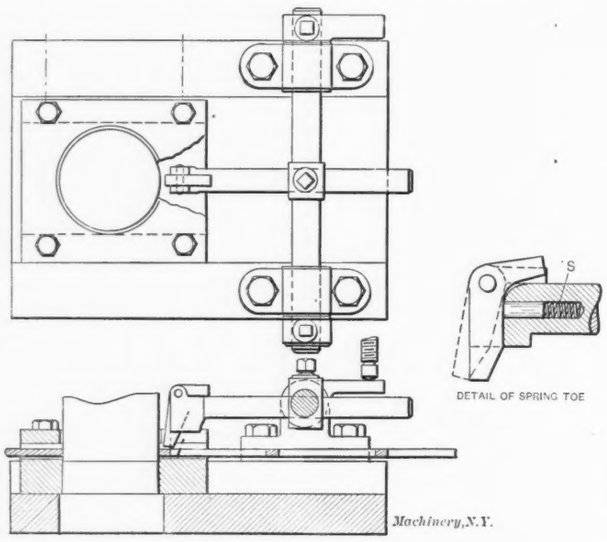


Fig. 6. The Spring Toe Latch Stop

by it too fast. Its operation is as follows: As the punch lowers and starts to cut the blank, an adjustable screw on the ram or punch plate lifts the latch. Its spring toe snaps forward and when the latch lowers, it rests on the scrap left between two blanks; hence it cannot fall back into its former place. When the operator pulls the stock along the latch toe drops into the next hole and brings the stock to a stop at the proper point, compressing the light spring *S* as it does so. This design is simple, rigid and effective. The spring toe here shown is preferable to the design which follows because it is light and requires but little tension on the stock to bring it to a stop.

The Side Swing Latch

The side swing latch is shown in Fig. 7 and it is but a modification of the latch shown in Fig. 6. When the punch descends, an adjustable screw hits lever *L* and lifts the latch. The whole rod *R* then springs forward till collar *C* stops against *B*. When the latch lowers it rests on the stock as did the spring toe latch. As the stock is pulled along the latch drops into the next hole and acts as a stop again. In this style the tension on the stock must be greater than with the spring toe latch because the whole rod *R* has to be pulled along against the spring *Q* until collar *D* stops against *E*. If this design were modified, however, so the side bearings would be used only for allowing the latch to swing, the toe could be constructed like the spring toe latch and would then be quite as effective as this type, though not so rigid.

Positive Heel and Toe Latch

While the two previous automatic stop-pins rely on gravity or a spring to bring them back in position, the heel and toe latch is positively operated. It is shown in Fig. 8, with the stripper removed. Its distinctive feature, which recommends it for use on a large variety of work, is that it is impossible for the stock to slip by it faster than one blank per stroke of the press. This is a very important matter when combina-

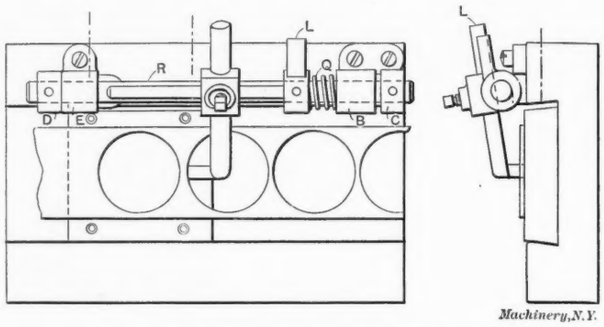


Fig. 7. The Side Swing Latch Stop

tion or gang dies are being used, because the pilot-pins so widely used require the guide holes to be punched just ahead of them. If the stock slips too far, the guide holes pass beyond the pilot-pins, and when the punch descends, the pilots punch their own holes, throw down a heavy burr and cause a delay—if nothing more serious.

Fig. 9 shows the catch in position to stop the movement of the stock at its point *A*. The stock is feeding to the right. The conical-pointed pin *B* is pushed by the spring *S* so that

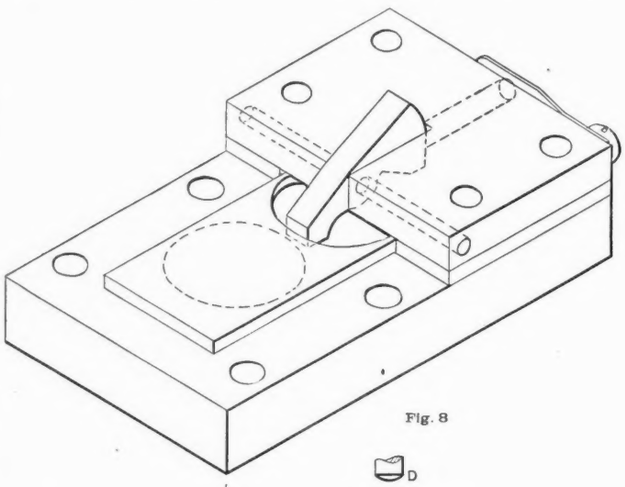


Fig. 8

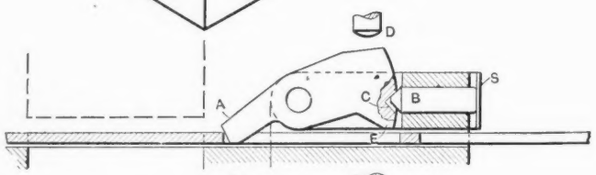


Fig. 9

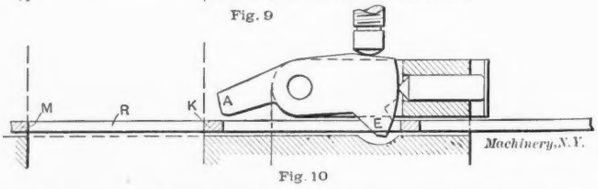


Fig. 10

Figs. 8, 9 and 10. Positive Heel and Toe Latch which prevents the Stock from moving more than One Blank per Stroke of the Press

it engages a conical depression *C* in the end of the catch. By this means the toe of the catch is pressed against the die. As the punch descends to cut the next blank an adjustable screw on the punch plate presses on the top of the catch at *D* and causes the heel to lower and the pin *B* to disengage the

notch *C*. The position of the catch is now shown by Fig. 10. Its heel *E* has been lowered into the hole left by the previous blank. It is held in this position by the pressure of the point of *B*. While this is sufficient to hold the catch in its new position, it offers but little resistance to its return to its original position. The stock may now be moved along. The metal *K*, left between two successive blanks, engages the heel *E* of the latch and lifts it easily. This causes the notch *C* to engage with the pin *B* and the catch snaps back into its first position. The toe *A* falls into the new opening *R*, and *M* comes to a stop against it. Since the metal *K*, between two successive blanks, cannot pass the heel of the latch without raising it, and since the heel *E* cannot rise without lowering the toe *A* far enough to catch the stock, it is evident that the action is positive. Hence the stock cannot jump ahead faster than one blank at a time. In constructing a stop of this kind care must be taken to allow under the heel *E*, Fig. 9, but little more height than the thickness of the stock. The length of the catch from toe to heel should be less than the opening left by one blank; then there will be no difficulty in starting the new ends of strips or coils. If necessary, however, the catch may be made so as to measure a little less than two or more openings in the stock. In such a case the catch would have to be tripped by hand until the first piece of stock *K*, between two blanks, had passed under the heel *E*. This would cause delays which would amount to considerable in the case of strip stock.

This style of stop-pin has been used successfully with gang dies cutting blanks from brass 1/32 inch thick, and cold rolled steel 1/64 inch thick. In the case of the steel blanks,

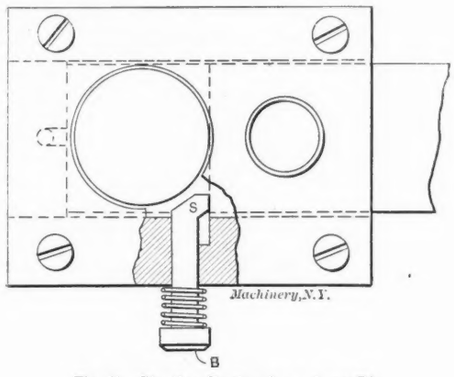


Fig. 11. Starting Device for a Gang Die

reels were used and the scrap was wound on a reel as it came from the die. By keeping the proper tension on the scrap, the stock was pulled through the die and kept against the stop-pin. Four thousand blanks per hour were made by this means. In view of the thin stock used and the fact that the dies were of the combination type, this was considered first rate. The stop-pin had to be set accurately because the thin stock prevented the pilot-pins from shifting it much in aligning it. Other precautions taken on account of the thin stock were to make the toe broad and to fit the stripper close to the front edge of the toe.

The Gang Starting Device

The devices so far described serve to stop the stock when it has passed the blanking punch. But there are many cases where two or more operations are performed on a piece before it reaches the blanking die and the usual stop-pin. The operator usually gages the proper positions by watching the end of the stock through openings in the stripper, but it is better to have temporary stop-pins that can be used for that purpose. Fig. 11 shows a starting device for a gang die with two punches. When starting a strip the button *B* should be pressed. This brings into action the temporary stop *S*, which locates the stock properly for the first operation. It is then released and springs back out of the way. The stock is then advanced to the regular stop-pin. As many of these side stops may be used as are necessary. Not only do they save annoyance and time, but they add to the life of the dies by preventing the partial cuts due to the stock entering too far at the start.

TWO FEED-STOPS OF WIDE UTILITY

C. W. D. AND W. B.

The authors make no claim of originality for the simple feed-stops here illustrated, nor is it desired to convey the impression that these stops are new or novel in their construction; experienced toolmakers will recognize them at once as "old acquaintances." There are certain points concerning

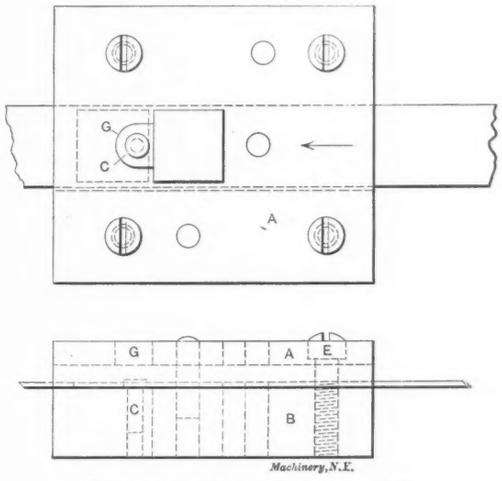


Fig. 1. Improved Form of Fixed Stop-pin

them, however, an explanation of which will be of benefit to those who are not experienced in punch and die work.

Fig. 1 shows a fixed stop-pin *C*, which is the most common of all feed-stops. It is the particular form of this simple stop to which we wish to call attention. The common way to make a fixed stop-pin is to bend over a piece of steel rod and drive it into the die. This appears simple enough, but we can say from experience that it is not so simple as it looks. As much as two feet of steel is sometimes used up in an attempt to make a bent stop-pin about one and one-quarter inch long. The difficulties and disadvantages connected with making a bent stop-pin are as follows: First, the difficulty of bending the pin at right angles without breaking it or bending the part to be driven into the die; second, after the pin has been made and hardened it is apt to break in driving it home to its place in the die because of its uneven shape; third, in driving the pin into the die it is apt to swing around out of its proper position making it necessary to knock it

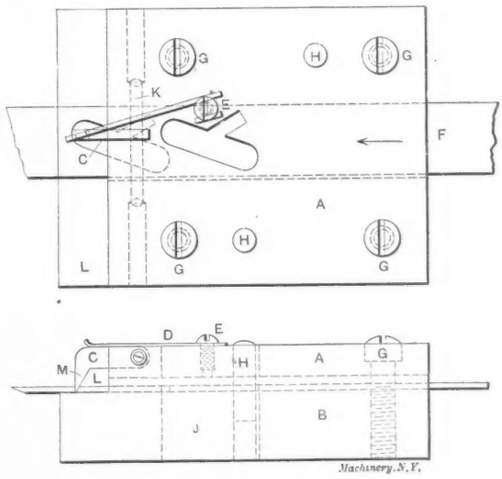


Fig. 2. Latch Stop-pin of Simple Design

around again and thus increasing the chances of breaking it. Every time the die is ground, this difficulty is experienced and the result is, frequent breakage and consequent loss of time in waiting for new stops. All these difficulties are overcome by making the style of pin shown in Fig. 1. This is simply a shoulder pin turned to a nice snug fit in the die. The shoulder, which acts as the stop for the stock, may be made

larger or smaller in diameter according to the width of scrap desired between blanks. This stop is quickly and easily made, is easily taken out and put back again after grinding the die, and it will last as long as the die itself. It is a good idea to cut a hole through the stripper *A* directly over the stop-pin as shown at *G* so that the operator can see the pin when the press is in operation.

The stop shown in Fig. 2 is excellent because of its simplicity, and also because of the great variety of work to which it may be applied. This stop is of the latch variety, but it differs from most stops of this type, in that it requires no mechanism to lift it. It is not operated by the action of the press nor by the punch, as is generally the case with latches. Its construction is simple. A hole is drilled through the stripper *A* to receive the pin *K* which passes through a hole in the stop *C*. The stop swings upon this pin. A light flat spring *D* is fastened to the top of the stripper so that the end of the spring rests on top of the stop. In securing this spring to the stripper, it is only necessary to place one end under the head of the screw *E* with a piece of the same material under the opposite side of the screw as shown in the plan view. By this method the spring can be quickly and easily attached or removed, and a straight piece of spring material can be used. The stripper, of course, should have dowel pins in it to insure its coming back in the same position every time the die is ground. The dowels and screws are shown at *H* and *G*, respectively. The stripper should also

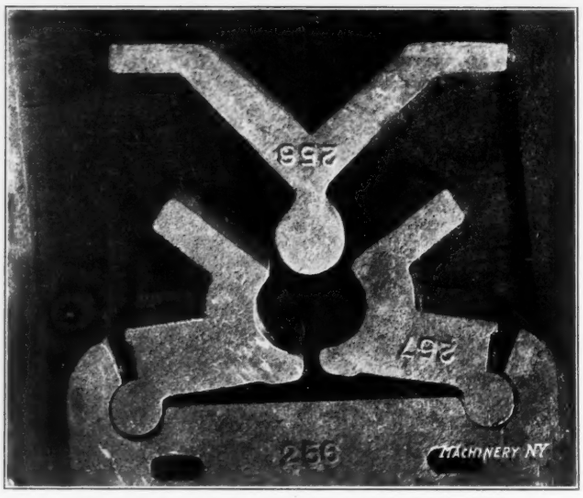


Fig. 1. Former for Making the Bracket shown in Fig. 3

be cut off at the stop end as shown at *L* so that the stop will be outside of the stripper and in full view of the operator. The action of this stop is as follows: The stock *F* is fed to the left, and as the punched strip passes the stop, the point of the stop *M* drops or rather springs into the hole made by the blanking punch. The operator then pulls the strip back against the straight outer edge of the stop, and holds it there until the next blank is punched. This process is repeated at each stroke of the press, the scrap between the blanks being pushed past the stop each time and then pulled back against it. The inner bevelled edge of the point *M* causes the stop to lift as the scrap between the blanks is pushed against it, while the outer edge, which is at right angles with the die, prevents the stop from lifting when the edge of the scrap is pulled back against it.

By this simple stop the operator can feed the stock at will without waiting for the operation of a mechanically-lifted stop, to say nothing of the time that is saved by not having to adjust an automatic stop. An operator, known to the authors, can make about 40,000 blanks per day with dies fitted with this form of stop on a press making about 100 strokes per minute. These stops are used only on hand-fed work.

* * *

Aluminum coins are to be circulated in France. The mint is ready to issue five and ten centime pieces of this metal. They will, of course, be much lighter than the ordinary coins, and have the advantage that they will not oxidize.

COMPOUND BENDING FORMS FOR THE BULLDOZER

ETHAN VIALL*

A short time ago, while visiting the shops of the Danville Car Co., at Danville, Illinois, the superintendent, Mr. H. C. Teipel, showed me several interesting bending forms which the shop foreman, Mr. A. S. Hesse, had made for use on their bulldozers. The forms shown in Fig. 1 are especially inter-

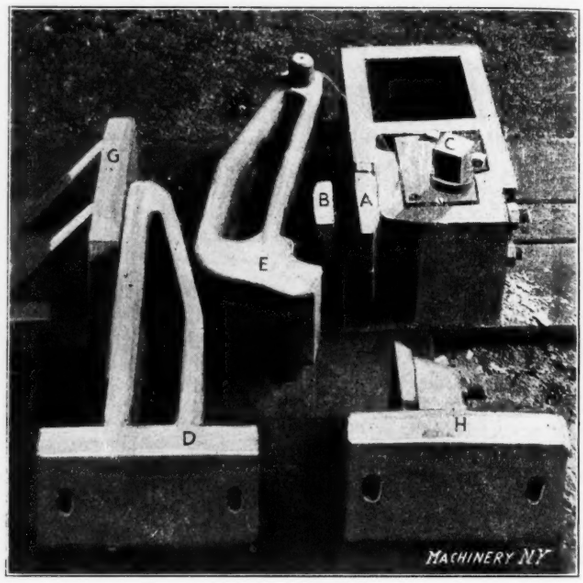


Fig. 2. Combined Former and Shear for Bending and Trimming the Gibs A, Fig. 4

esting from the fact that they were so cast that no machining was necessary in order to assemble them ready for use. Possibly a little filing was needed, or a small lump or two had to be knocked off with a hammer and chisel, but that was all. This device is intended to form the bracket, shown in Fig. 3, but a number of other brackets or hangers, can be made with formers constructed on the same principle. It will be noted

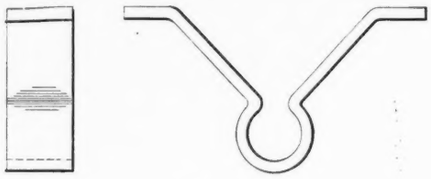


Fig.3

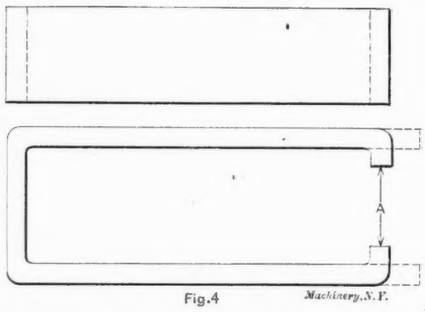


Fig.4 Machinery, N.Y.

Figs. 3 and 4. Pieces formed by the Tools shown in Figs 1, 2 and 6

that stops are cast on the back plate (which is the lowest in the illustration), against which stops on the wings of the pieces above strike, in order to locate them properly for the work. The planning of this former so that it would work just right, was not as easy as it looks at the first glance, and a study of its action will show several reasons.

A more complicated former is shown in Fig. 2. This former was made to bend and trim the drawbar-pocket gibs *A*, Fig. 4. In using this former the bar is placed between part *A* and

* Associate Editor of MACHINERY.

the clamp-jaw *B*, which is tightened by turning the eccentric *C*. The gib is now bent by the part *D*, which is fastened to the bulldozer ram, shoving over the gib-former *E*. During the bending of the gib, the part *D* is steadied and guided by the part *G*, which is bolted solidly to the bed of the bulldozer. The end of the gib is trimmed off by the shear-blade on part *H*, which slides past the outer edge of the blade on part *A*.

The adjustable male and female parts of the radius bender, shown in Fig. 5, are used to bend iron parts that would otherwise require about twenty different forms.

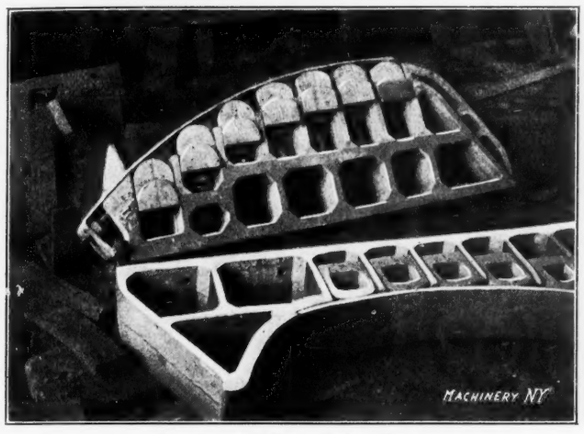


Fig. 5. Adjustable Bending Form

The draft-gear yoke-bender shown in Fig. 6, was made in the Ft. Wayne shops of the Pennsylvania Railroad and is only slightly different from those used elsewhere for the same purpose. The wings *A*, *A*, and the parts *B*, *B*, used to push them around during the stroke of the bulldozer ram, are all pretty well cored out to lighten them. The iron to be bent, is clamped between the form *C* and the sliding part *D* which is operated by the lever *E* turning an eccentric located in the block *D*. The yoke shown in Fig. 4, having straight ends as indicated by the dotted lines, is the product of this tool.

* * *

SPECIAL CENTERS FOR TAIL-STOCK

WALTER GRIBBEN*

The tubular shaft of tool steel, shown in section in Fig. 1, was so long in proportion to the diameter of the hole that it could not very well be turned on a standard bench-lathe arbor, and rather than make a special arbor of extra length, the tail-stock fixture shown in longitudinal and cross section in Fig. 2 was made to do this job. It has since proved remarkably useful on many other jobs, and is now considered a standard appliance in my bench-lathe outfit.

The body *A* is made of rectangular steel, with a 3/16-inch hole bored and reamed its entire length. The taper shank is turned true with the central hole, and fits the tail-stock spindle the same as an ordinary center. The binder *B*, and screw *C*, with the lever handle *D*, will hold any piece of 3/16-inch round stock, or any special piece with a 3/16-inch round stem, so that it will be in line with the live spindle.

For the job shown in Fig. 1, the plug *E*, Fig. 2, was made, the shank *F* being an easy fit in *A*, while the part *E* is ¼ inch in diameter at its outer end, and slightly tapering, so that it is about 0.001 inch larger on the inner end. The part *E* was hardened, tempered, and polished smooth, while the part *F* was left soft. This plug answered as a dead center for the end of the tubular shaft to run on while turning the outside. As a driver for the other end, a piece of rod larger than the hole in Fig. 1 was held in the live spindle and turned to a tight wringing fit in this hole. This left the outside of the work entirely free to operate on, including the turning of both ends at one chucking, which insured all the parts being true with one another. The slight taper on *E* provided for any fine gradation between a running fit and a tight fit to be obtained on the tail-center end, by adjusting the tail-spindle back or forward.

* Address: 314 Halsey St., Brooklyn, N. Y.

In work of this character, no attempt is made to preserve the driving plug for subsequent jobs, as it does not need to be hardened, nor does it need to be polished. It is a comparatively easy matter to turn one up each time it is needed, and it is then sure to run true. They are generally made on the end of a stock rod, and after the job is completed, the driving rod is put back in stock. This, of course, is from the jobbing point of view, and not from a manufacturing standpoint.

The hardened steel plugs, similar to *E*, are made for each job as it occurs, and are preserved for future use. Fig. 4

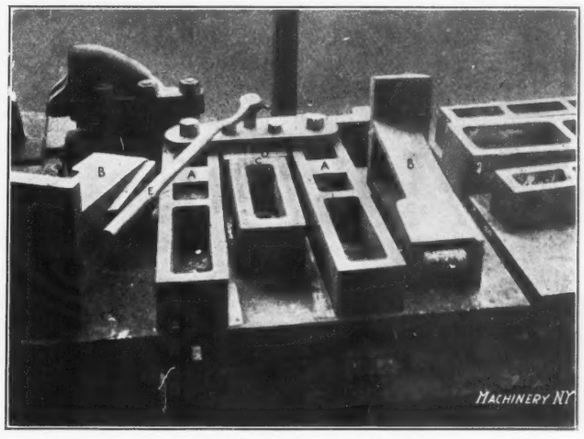
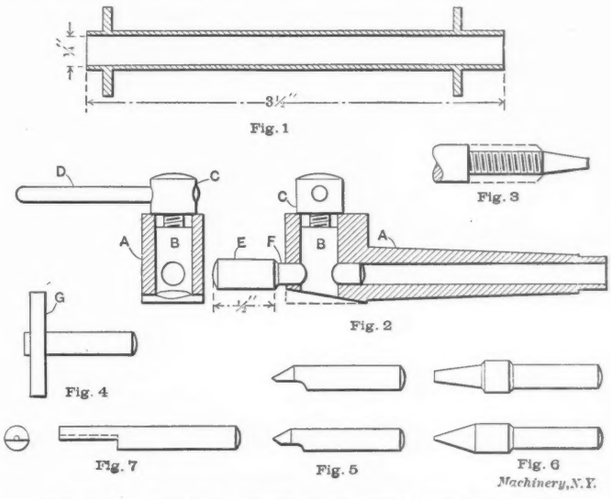


Fig. 6. Draft-gear Yoke Former

shows a sheet brass disk *G*, soft soldered onto a short piece of 3/16-inch wire, the edge of *G* being turned true after soldering on. This makes a convenient kind of center on which to run the end of a long piece of drawn brass tubing while truing the end, or cutting a thread on the outside.

Another use to which the tail-center, Fig. 2, is put is to hold short, stubby, flat drills for starting a true hole in chucked work. If the hole is in thin work, it may be drilled clear through with one of these flat drills, but if a hole has to be drilled in some distance, it may be started with one of the flat drills and finished with a twist drill.



Figs. 1 to 6. Special Tail-center for the Bench Lathe, and Auxiliary Attachments

In the outfit of plugs to go with Fig. 2 there are two male centers cut partly away to different amounts, as shown in Fig. 5, a female center with a much smaller hole than in the regular female center, and a 60-degree countersink for centering shafts. Some of the plugs are special in their nature, as shown in Fig. 6, and are hardly worth keeping. These were made for turning shafts that were to run on pointed screws of a special angle, and as only one shaft of each kind was to be turned, the plugs were not even hardened, but were left soft and kept well lubricated when in use. The stock from which one of the screws was to be made was chucked and its point turned to the specified angle, as in Fig. 3. A small dog was then clamped on the part shown

dotted. This made a live center on which to turn the shaft, one of the plugs shown in Fig. 6 being used as a dead center. After the shaft was completed, the pointed screw was turned down for the shank, threaded and cut off, thus performing a double duty, as live center first, and as a finished screw for the completed machine afterwards.

Having to make a tap 0.040 inch diameter and 100 threads per inch, a piece of 3/16-inch brass rod was drilled lengthwise about ½ inch deep with a 0.040 drill, after which the outer end of the rod was cut partly away, as shown in Fig. 7, leaving about two-thirds of the original diameter of the hole in the brass. When this was clamped in the tail-center, Fig. 2, it made a very good steady rest, or back rest, for the slender wire to run in while doing the threading. The threaded part of the tap was only ⅜ inch long. Of course, a hardened steel plug would have answered much better, but the job was in a hurry, and the brass plug was more quickly made, and was plenty good enough.

The part shown dotted in Fig. 2, is cut away to clear the turning tool when finishing the end of a tube or a solid shaft with a straight hole in the end. The central hole in Fig. 2 goes all the way through, but it does not need to. It was made that way because it was easier to get all the parts true, the hole being made first. Since making this fixture, it has occurred to me that it would have been an excellent device to use on a lathe that I worked on many years ago, which was somewhat out of alignment. In that case the central hole would be bored in place after the taper shank was fitted to the tail spindle, taking the precaution, of course, to mark the fixture and the tail spindle, so that the fixture would always be placed, when in use, with the same side up as when it was bored.

* * *

MACHINE SHOP PRACTICE*

LAYING OUT WORK—2

Before laying out a machine part it is first well to consider its particular requirements in order to obtain a definite idea of the relation that the various surfaces must bear to one another when the part is finished and assembled; and, as the method of procedure is governed somewhat by the way in which the part will subsequently be machined, it is also advisable to first determine the most practicable method of machining, before beginning to lay out the work. As an illustration of the kind of work which the machinist is often called upon to line out, we have selected the engine cross-head shown in Fig. 1, which is a type widely used. The shaded portion represents the main casting, and the dot-and-dash lines the shoes, or gibs as they are sometimes called, which are adjusted along the inclined surfaces *A* and *B* when there is too much play between the guides and the cross-head. In this particular case the principal requirements are that the axes of the piston-rod hole and the wrist-pin hole be at right angles; that the axis of the wrist-pin hole also be at right angles with the vertical center line *b-b*; that the inclined surfaces *A* and *B* have the same inclination to the center line *a-a* and be equi-distant from it; and that the guiding surfaces *H* be parallel with the axis of the piston-rod hole. Keeping these requirements in mind, we shall proceed to locate lines on the casting indicating the finished surfaces. After inserting centering pieces in the cored wrist-pin hole on each side and in the piston-rod hole as shown, locate the points *c* and *e* central with the outside of the bosses. A coat of whiting and alcohol, or chalk, should next be applied to those surfaces upon which lines are to be drawn. The casting is now ready to be set in an upright position on the surface plate, as shown in the illustration. The blocks which would be required to support it in such a position have not been shown, in order to avoid a confusion of lines.

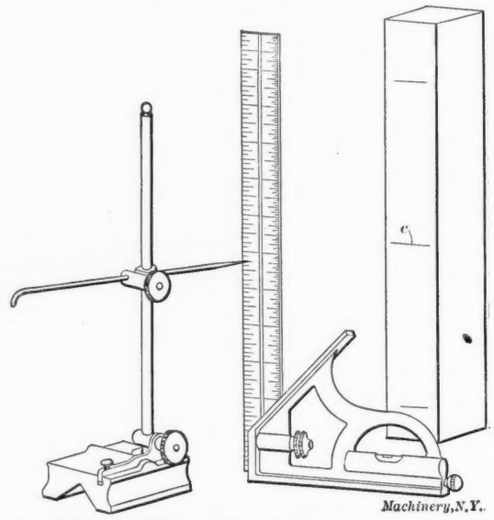


Fig 2. Setting the Surface Gage to the Dimension u, Fig. 1, by the Combination Square

The rough sides of the casting are set at right angles to the surface plate by the use of a square, as shown in the end view. The center *c* and the two centers *e* (see end view) are now set in the same horizontal plane by the use of the surface gage *G*. This is done by inserting the pointer *P* of the gage in one of the centers and then moving the gage to the other centers to see if they coincide with the first. It may be necessary in order to set these three centers in the same horizontal plane to move the two centers *e* toward each other slightly. It is better that each center be moved in order that the finished hole will be as nearly concentric with the outside of the bosses as possible. When the casting is thus set, the surface gage is used to draw the center line *a-a* on each side and across the end of the cross-head. This is done by holding the scriber against the casting while the base of the gage is moved along the surface of the plate; obviously a line drawn in this way will be parallel with this surface. Ascertain from the drawing in which direction the wrist-pin is to enter the cross-head in order to find out from which side the hole for this pin will be bored, and then, with point *e* as a center, scribe a circle equal in diameter to the small end of the wrist-pin hole. This circle will be used to set the casting by when boring the hole in the lathe or boring mill. Another circle, the diameter of the small end of the piston rod hole, should be scribed with point *c* as a center. With a pair of trammels, a line *f* should be located a distance *x*, as given on the drawing, from the center *e*. We shall assume that the dimension *y* is given, and that the taper of the inclined surfaces *A* and *B* is in inches per foot. Then to lay out lines for these tapering surfaces, locate points *h* and *h* equi-distant from the center line *a-a* and a distance *y* apart. With a square draw a line *i-i* 12 inches from the face *K*. With the surface gage transfer the points *h* to the line *i-i*, as shown, and then locate centers above and below these points a distance *w* equal to the taper per foot. Lines which are then drawn through these centers and the points *h* will have the

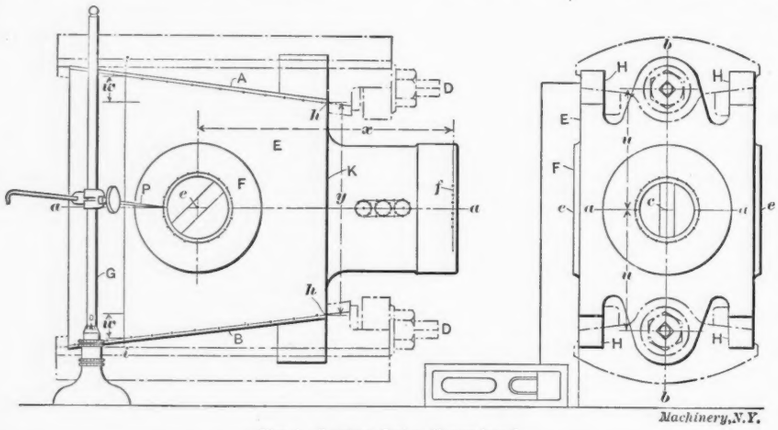


Fig. 1. Laying Out a Cross-head

* With Shop Operation Sheet Supplement.

taper required. If the casting is not large enough to permit line *i-i* being drawn 12 inches from the face *K*, of course the same result would be obtained if this distance were a fractional part of a foot, providing the distance *w* were laid off to the same fractional part of the taper per foot. When locating the centers of the bolts *D* distances *u* above and below the center line *a-a*, the pointer of the surface gage should first be set to coincide with center *c*. The pointer may then be placed against scale of a combination square, and the scale moved vertically until the pointer coincides with one of the divisions, as shown in Fig. 2. If the dimension *u* then be added to the inches and parts of an inch indicated on the scale opposite the pointer, the sum thus obtained will be the division on the scale to which the pointer should be set when scribing the horizontal center lines for the bolts *D*. For example, if the gage pointer showed that the center line *a-a* was the same height as the 5¾-inch division on the scale, and if the dimension *y* on the drawing was 5¼ inches, the gage pointer would, when scribing the center line for the upper bolt, be set to $5\frac{3}{4} + 5\frac{1}{4} = 11$ inches. The center for the lower bolt would, of course, be obtained by subtracting 5¼ from 5¾. In this way the scale of the combination square can often be used for accurately setting the gage pointer to vertical distances between points not in the same plane. A parallel block placed in a vertical position may also be used for this purpose. A center line *c*, coincident with the center in the work, would first be scribed and then arcs central with this line and the required distance apart would be struck with a pair of dividers or trammels.

One method of machining this cross-head would be to first bore and ream the wrist-pin hole concentric with the circle drawn for it, and at right angles with the rough surface *E*; the boss for this pin should also be faced. This finished boss can then be clamped against an angle plate (preferably on a vertical boring mill) when setting the casting for boring the piston rod hole. In this way the axes of the holes for the piston rod and wrist-pin will be at right angles, and if the center line *a-a* on the casting is set square with the table or face-plate, the axis of the two holes will also be in the same plane. By bolting the finished face *F* against an angle plate on the planer, the planes in which the finished surfaces *A* and *B* lie, will also be parallel to the wrist-pin axis, and the finished sides *H* for the shoe fittings will be parallel to the axis of the hole for the piston rod.

* * *

IMPROVEMENT VS. HUMANITY

An American and German were traveling by rail in Germany through one of the forests for which the country is noted. The wooded expanse on either hand showed the care of the trained forester. The trees were free from dead branches, and on the ground there was little or no debris. The roads were laid out with mathematical exactness; the sides were free from weeds and the gutters carefully graded and clear of obstructions. In short, the whole appearance of this great forest was that of a well-kept park, although miles and miles in extent. The German waxed enthusiastic and was constantly calling the attention of the American to the various features that attracted his admiration. He could not say enough for the beauty of the scene, for the well-kept appearance of the trees, the fine roads and the evidences of a mastery of nature and a carefully planned conservation of a valuable resource.

The American at last grew somewhat impatient and said: "You see one phase of this scene only, and that is the woods and the roads, while I am more concerned about another phase, which is the human side. Behold those men and women peasants broken down with toil before their time, stumbling along in wooden shoes, without hope, without courage and destitute of ambition! That is the other side of the scene not so fine. To me this scene is very depressing, for I see in it nothing for humanity. Of what good are all these roads, the well-kept forest, these water courses, when the men and women whose unremitting labor is required to do this work, have no joy in the prospect? Human happiness is worth more than all the improved roads and forests together, for without it all else is worthless."

GERMAN BENDING AND STRAIGHTENING MACHINE

A machine for bending cold iron and steel of round, square, T, I, channel and other sections is shown in Figs. 1 and 2. This machine which is built by Brüder Boye, Neue Friedrichstrasse 59, Berlin, Germany, is designed for bending and straightening small quantities of work of a special nature, which would not warrant the employment of special machines with expensive tools, such as bulldozers. The need of such a machine has long been felt by bridge and crane building establishments, shipyards, railway shops, machine

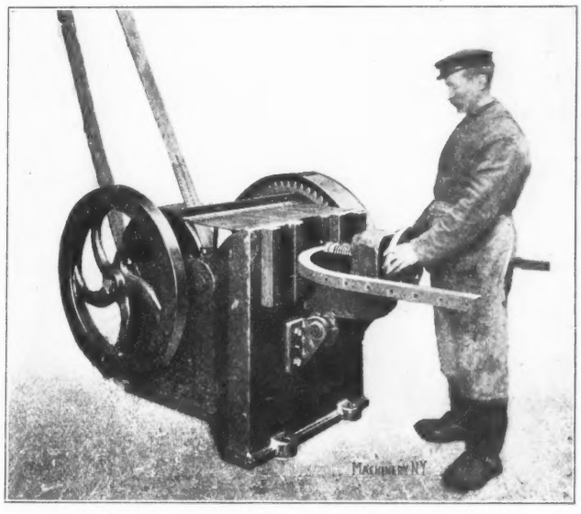


Fig. 1. The Power-driven Bending and Straightening Machine forming an Angle-iron

shops, etc. Although tools performing this work are in use, they are generally hand-operated and the results have been more or less unsatisfactory, both in regard to the output and the quality of the work produced.

As may be seen in the line engraving Fig. 2, the machine consists of a strong frame in the center of which is a massive steel ram *A*. This ram is connected at one end by an eccentric, which actuates it, and it is supported at the other by a roller *D*. In the end of the ram there is an adjustable spindle *C* which comes directly into contact with the work. By varying the position of this spindle, the piece being bent will

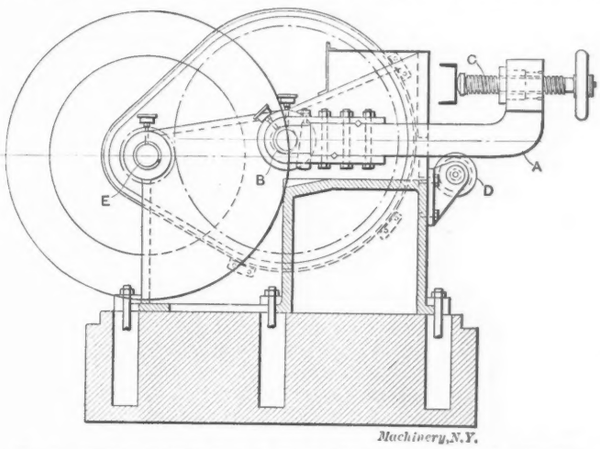


Fig. 2. Vertical Section through the Bending and Straightening Machine

be subjected to a greater or less pressure and the radius of the bend will be varied accordingly. The shaft upon which eccentric *B* is mounted is connected to the driving shaft *E* by reduction gearing. The speed of the driving shaft is 110 revolutions per minute, and the resulting speed of the ram is 25 strokes per minute. While the stroke of the ram, which is approximately 1 inch, is not changeable, the distance between its working end, that is the end of *C*, and the frame can be changed, as before stated, by simply moving *C* in or out by the hand-wheel shown, thus subjecting the work to a greater or less amount of pressure on each individual stroke. Obviously, this machine can be used either to bend

straight bars to any desired form or to straighten crooked bars. These bars may be round, square or any desired shape and the iron can be bent at any point by turning the work to the desired position. The various pieces in Fig. 3 show what uniform results can be obtained with this simple machine. Pieces having the same section throughout can easily and quickly be bent to approximately a true circle, providing the spindle *C* is not adjusted after a bend is started and the work is fed practically the same amount for each stroke. It is said that this machine bends the various

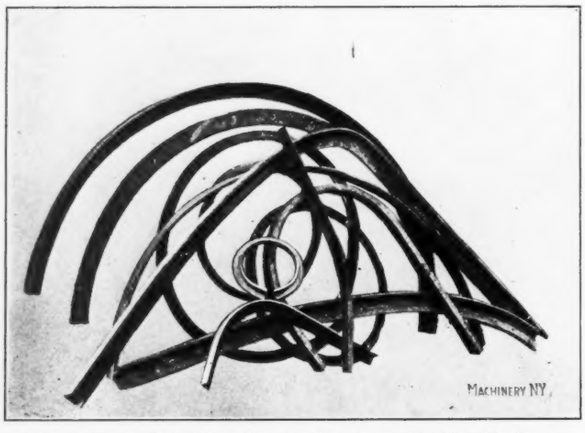


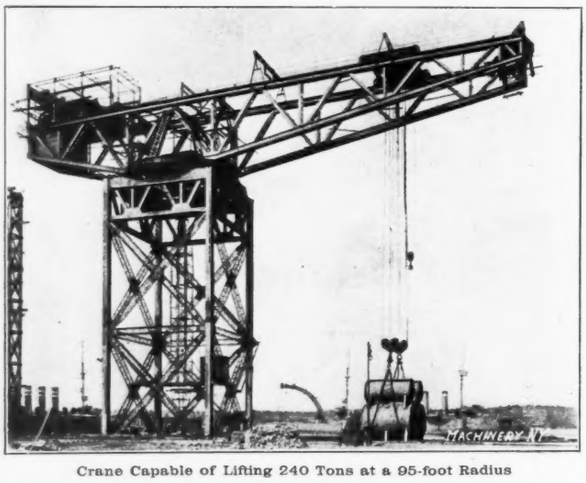
Fig. 3. Some of the Work done by the German Bending Machine

sections without any appreciable amount of buckling, which, considering the simplicity of its construction, is quite remarkable. When bending long pieces, the ends are supported by tables or horses which are arranged on both sides of the plunger or ram. Angle iron 2 by 2 inches in size can be bent to a minimum radius of 8 inches, while 4 by 4-inch angle iron can be formed to any radius greater than 2 feet 6 inches. The smallest radius to which an 8 by 3-inch channel can be bent is 4 feet 9 inches. The radius to which any material can be bent is, of course, dependent on its stiffness. About 3 horse-power is needed to drive this machine, and its weight, when ready for shipment, is approximately 2 tons.

* * *

THE LARGEST CRANE IN THE WORLD

The accompanying illustration shows what is stated to be the largest crane in the world and is the crane that was referred to in a short item in the August issue of MACHINERY,



Crane Capable of Lifting 240 Tons at a 95-foot Radius

engineering edition. As there stated, the crane will lift 160 tons at a 95-foot radius, and when tested it lifted a load of 240 tons. The illustration shows the crane while being tested ready to lift the load mentioned. The crane is erected at Devonport Dockyard in England. Its total height is 166 feet, its length over all 230 feet, and its weight 950 tons. It was built by Messrs. Cowans, Sheldon & Co., of Carlisle, and was designed by Mr. J. W. Branston.

THAT NEW APPRENTICE BOY

A. B. SAW

Terry, the new apprentice, came into the pattern-shop about three months ago, bringing his dinner wrapped up in his apron and towel and looking for all the world like a raw recruit from the Emerald Isle; but after he had been there three or four days, he was one of the most welcomed boys that ever got his trademarks in the shop.

He was, as one of the journeymen expressed it, "always keeping us in good spirits by doing funny stunts and asking innocent questions about his work."

The second day that he was in the shop, the boss came to him, where he was sorting screws, and said: "Terry, you can have that bench up there by the band saw for a while, it's kind of old but it will hold you for a time." "All right, sor," says he. So hurriedly finishing his work, he went up to the bench and started to tidy up a bit, feeling as big as life to think that he had a bench all his own.

When he had it fixed up nice and clean, he noticed with dismay that the top of his bench was full of small holes and knife cuts, while the tops of the adjoining benches were smooth and shiny. However, this down-cast mood soon gave way to one of delight because he had an "idea" that would remedy the unsightly appearance of his bench. "Why not fill up those holes with beeswax?"

For two hours he dug and worked at the old bench filling the holes with beeswax. This made the men jolly him a

"Begorra, I'll give it a good draft"

good deal, and they dubbed him "Beesy," a name he went by for the rest of his apprentice days.

Not long after this little incident, he was given a flange to make, twelve inches outside diameter, six inches inside diameter, and about two inches thick. He turned it up in the lathe and, as he thought, "made a pretty foine job." He took it up to the boss, who, after measuring it up, tried a small square to the edges. "There's no draft on it, Terry, give it a little draft and it will be all right."

Terry went back to his bench with a perplexed look on his face, until the meaning of the word "draft" dawned on him. "Begorra, I'll give it a good draft," said he, and at that he put the flange upon the window ledge and opened the window about three or four inches, letting the cool breezes from the water blow on his pattern.

About half an hour afterwards he came over to my bench and said, "Do youse think there's enough draft on me pattern, Mr. Saw? It's been there thirthy minutes."

Well, I explained to him, with a straight face, what the meaning of "draft" was, when applied to a pattern; but I must confess that after he had gone I had to give way to my suppressed mirth, and when the story was repeated to some of the others, they joined in with me.

* * *

The minute a man begins to consider himself indispensable he ceases to be.—*The Silent Partner.*

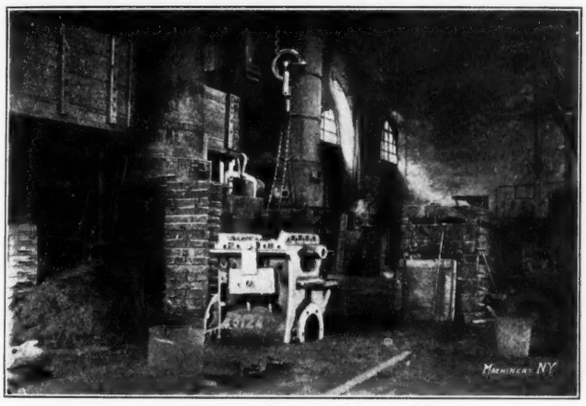
LETTERS UPON PRACTICAL SUBJECTS

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively

CASTING NEW FACES ON WORN VALVE SEATS

The accompanying view shows the operation of casting a new face on an old valve seat of a locomotive cylinder, as it is performed at the Firenze (Florence) repair shops of the Italian State Railways. The illustration shows the cylinder with the mold clamped to it ready for the pouring of the metal from the adjoining cupolas. Briefly described, the process consists of removing the worn or damaged part that is to be renewed, and fixing in its place the mold of the new part. Before running the metal, the cylinder is highly heated and then the pouring is performed in such manner that the metal runs freely over that surface of the cylinder which is to be fused and welded, and then passes out through a hole such as is shown in the side of the mold in the photograph. After running from 200 to 500 pounds of metal, the old metal softens and melts; the escape hole is then plugged and the mold filled up to the top of the runner head.

Unless a cylinder has been rebored so many times as to approach its final limits for thickness, this process is found to be cheaper than casting new cylinders and then machining



Casting a New Valve Face on an Old Cylinder—Italian State Railway Shops at Florence

them. The new gas "welding" processes would not be so economical in Italy considering the thickness to be melted for a weld joint; this too is the experience in French railway shops where autogenous welding (*soudure*) has been practiced for some time with considerable success up to a certain thickness, past which ordinary methods become cheaper.

C. R. K.

A VARIABLE LINEAL SPEED DRIVE

Fig. 1 shows a general view of a slide *A* which moves back and forth in a straight line with a variable speed by means of a common rack *B* securely mounted on the slide, and a spiral spur gear *C* keyed on the shaft *D* running at a constant speed. From the drawing it can easily be understood that this spiral gear can only make a part of a turn or possibly a little over a turn before reversal, in order to move the slide in the desired direction. The reversing of the shaft *D*, on which the spiral is fastened, is done by a jaw clutch body *E* sliding on a feather on shaft *F*, and engaging automatically with either one of the two pulleys *G* and *H*. These pulleys, located one on each side of the clutch body *E*, run continuously in opposite directions, thus changing the direction of the rotation of shaft *F*. On this shaft there is a worm fastened which meshes with a worm-wheel fastened to the spiral gear *C*. The rack is mounted on the slide at a certain angle depending upon the required variation in speed, which is in direct proportion to any line *m*—*m'* or *n*—*n'* drawn from the pitch line of the rack perpendicular to the center line *I*—*J*. It would not be advisable to mount the rack on the slide at a steeper angle than 30 degrees. If the angle be more than this a greater resistance to the movement of the slide will occur.

The diagram, Fig. 2, shows how to construct the spiral gear when the pitch and the angle to which the rack is set are given.

The center line of the spiral gear is located as near as possible to the lower end of the rack, just enough space being left to get a good size hub around shaft *D*. In this way the

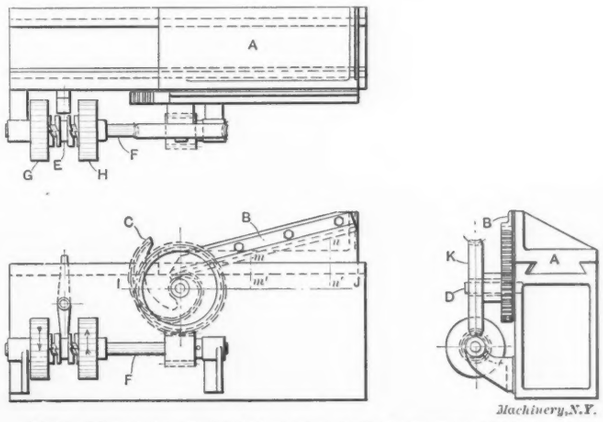


Fig. 1. Mechanism with a Spiral Spur Gear for Imparting a Variable Lineal Speed to a Slide

smallest possible spiral gear required for the movement will be obtained, providing that the movement of the slide is not too great, in which case the size of the spiral gear may have to be increased in order to get the right number of teeth. First, space off one-half of the pitch *a*, *b*, *c*, *d*, *e*, etc., on the proper length of rack and then project lines to the center line *I*—*J* from each one of these divisions. With *A* as a center and *aa'*, *bb'*, *cc'*, *dd'*, *ee'*, *ff'*, *gg'* as radii, strike small arcs as shown at *b''*, *c''*, etc. Space off half of the pitch on these arcs, going from one to another to get the intersecting points for the pitch lines of the spiral gear. By rights, the pitch should be measured on the spiral, but for a small pitch

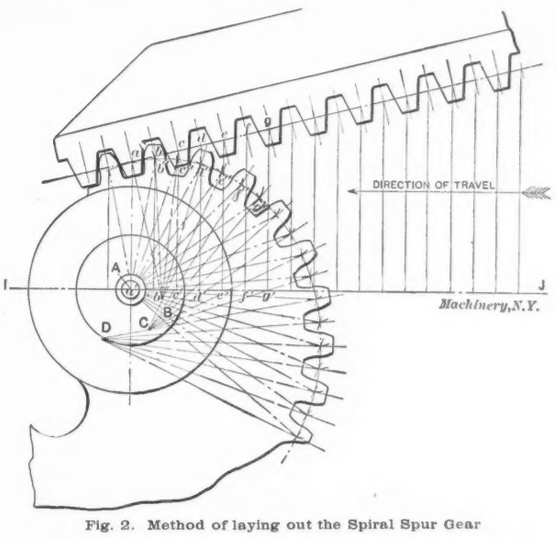


Fig. 2. Method of laying out the Spiral Spur Gear

the difference is so slight that it need not be taken into consideration. When all the intersecting points are found, find the centers *B*, *C*, and *D* needed for forming the spiral. Lines drawn from these centers through the intersecting points *b''*, *c''*, etc., will give the center lines for the teeth and spaces in the spiral gear.

For cutting the spiral gear, a templet was made having the correct shape of the teeth according to the various radii in the spiral. This templet was fastened on the blank and the spiral was cut in the regular way, only that it could not be cut with one cutter as the shape of the tooth changes with the spiral. [The paradoxical name of spiral spur gear given the gear illustrated in connection with this article.

illustrates the folly of naming what is really a helical gear a spiral gear, as the gear here shown is truly spiral in form. —EDITOR.]

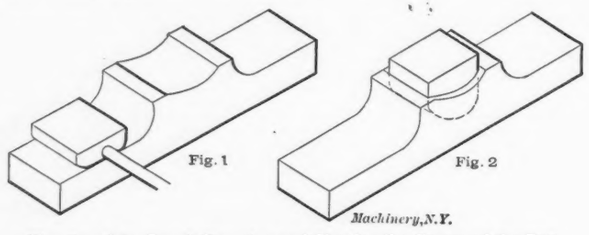
EDWARD PERSON.

Brooklyn, N. Y.

FORGING DRIVING BOXES

Forged driving-boxes are preferred to steel castings by many European railway works. On account of their great height there are some difficulties in the way of forging them direct in the press. The accompanying sketches show how this work has been simplified at the Epernay shops of the French Eastern railways.

The billet for the driving-box forging is first rough-dressed as shown in Fig. 1, and then, with the aid of a die, the hollow is shaped in the crown as at Fig. 2. The third operation is to channel the sides as shown in Fig. 3, and then swage the middle portion on the block, or matrix, as in Fig. 4. The forging is then passed to the press in which it is given a truer form by a die and matrix. The sixth operation is to close up the sides or cheeks of the box by straightening out the curved ends according to the manner shown in Fig. 5, and the seventh and final operation is to square up the forging on the form or die as in Fig. 6.



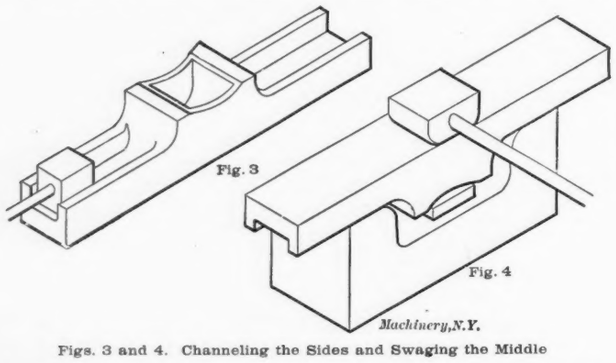
Figs. 1 and 2. Rough Dressing and Shaping the Crown of the Box

The weight of the billet being 264 pounds, the forging thus far completed will weigh 172 pounds, and, after machining, the finished driving box will weigh 105 pounds. For heavier finished boxes the weight of the billet and forging are correspondingly heavier.

C. R. K.

BLIND ACCEPTANCE OF AUTHORITIES

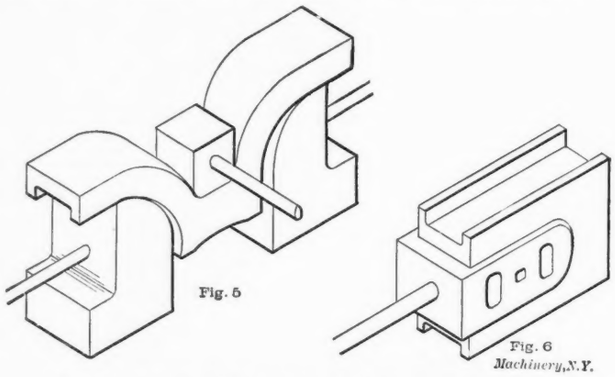
In the June number of MACHINERY, in an editorial, some space is devoted to what is perhaps the greatest fault of the young college-bred engineer—that of adhering blindly to rules laid down by the authorities. No text-book, or college professor, however, can overcome the handicap of a poor memory or lack of good common sense; neither should such authorities be credited with mistakes resulting from such inability, nor should ridicule emanating from it reflect on them.



Figs. 3 and 4. Channeling the Sides and Swaging the Middle

Incidents concerning the deeds of college engineers are plentiful, and two old, familiar ones may bear repeating. One young man while employed in a drafting-room was given the task of making the necessary drawings for a certain mechanism. When completed he turned the "drawing" over to the chief along with twelve closely written sheets which he said were directions for the drawing. The other engineer in writing of a new locomotive stated that it weighed 160,000 pounds, though the actual weight was slightly in excess of this, for the boiler carried 200 pounds of steam!

Just how some students manage to graduate is hard to conceive. Quite recently a graduate of the engineering school of a large university was unable to tell what part of a dynamo was the commutator. It is impossible to believe that any part of a college training is responsible for such glaring ignorance and errors. Happily for him, the college engineer may sometimes link arms with the practical man and share the "knocking" that his co-workers are only too ready to administer. Witness the following: The mechanical superintendent of a certain factory, a man of 35 years experience in various positions from apprentice to machine shop owner, was telling with a show of pride how he had forestalled a move to put 12 presses on the fourth floor of one of their buildings. The machines were hydraulic presses weighing 1,500 pounds and capable of exerting 35 tons on any article placed between the platen and bed. "Why," said he, "those floor beams are only 2×12, set 2 inches into the brick, and with all 12 presses working there would be 400 tons on that floor; I'd resign my position before risking lives that way."



Figs. 5 and 6. Closing in the Sides and Squaring the Forging

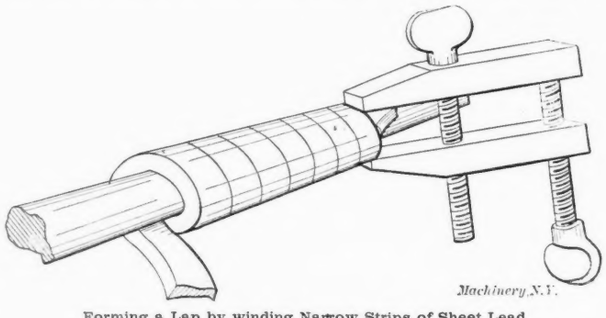
Let us have all the training obtainable; that, tempered with good common sense and coupled with broad, practical experience will give us the engineer par excellence.

Middletown, N. Y. DONALD A. HAMPSON.

A CHEAP BUILT-UP LAP

A great deal of machine work would be considerably improved by having the holes which require accuracy, lapped smooth and true, but the equipment of the average machine shop does not include laps of all sizes, and if a few are carried the chances are all in favor of their being of the wrong size for the work in hand.

It does not take very long to make a lead lap of the ordinary kind, but molds must be provided for casting them, and, as the variety of work to be lapped is infinite, it is practically impossible to have a complete set of molds. Casting laps upon a tapered arbor, as is customary, also requires that the holes in the mold must fit the arbor to be used, at the place where the lap is desired on the arbor, and as that place may vary or one may wish two separate laps on one arbor for lapping journals some distance apart, variations of hole size must be compensated for by the use of clay or some similar expedient. Another fault of the cast lead lap is its tendency to run dry and bind in the hole, unless carefully scored to provide oil channels over most of its surface. It also must be split if of any considerable size as compared to the arbor, or it will require too much of a blow on the arbor to expand it, if this be possible at all.



Forming a Lap by winding Narrow Strips of Sheet Lead around a Taper Arbor

To reduce the work required to make a lap, and provide material which can always be worked up into a lap on short notice without casting and without the use of molds, keep a piece of sheet lead about 3/16 or 1/4 inch thick, or even thicker, on hand. Use the same taper arbor as for the cast lap, and place it between the centers in the lathe. Cut a strip from the sheet lead about ½ inch wide with the tin shears and fasten it to the arbor a little nearer to the small end than you wish the end of the lap to be, with a clamp or lathe dog, as shown in the illustration. Now wind the lead strip as tightly as possible upon the arbor in the same way that a helical spring would be wound, tapping the lead with a hammer to produce an impression of the spline, if a splined arbor is used. If one layer of the lead does not give a lap large enough to turn to the desired size, another layer can be wound over the first in the same direction, but beginning at the opposite end. This operation may be repeated until the desired diameter is obtained, after which it is often well to fuse the ends together with a soldering iron if the lap is very large. The whole can now be driven firmly onto the arbor and turned true and round in the lathe. The helical grooves left between the various convolutions of the strip serve admirably as channels for the proper distribution of the oil and emery, and this construction will be found more elastic and easily expanded than the conventional cast lap.

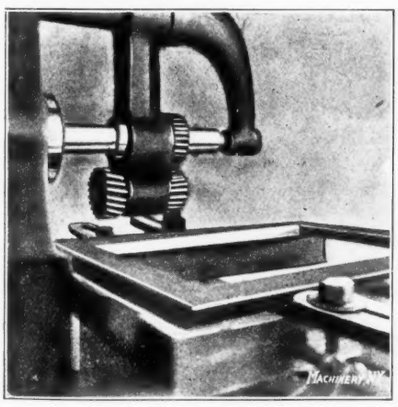
Needless to say, the lap must be run so that friction with the piece to be lapped will tend to wind the lead strip more tightly around the arbor; this proves quite an advantage rather than a disadvantage as it makes it possible to use an unsplined arbor without the constant danger of the lap slipping on it. On laps having but a single layer of lead it will be found desirable to reduce the diameter for an inch or so at the small end to prevent friction with the piece to be lapped, which would tend to unwind it. On laps of two or more layers this will not be necessary. HERBERT L. THOMPSON.

Elgin, Ill.

CORNERING TOOL FOR THE MILLING MACHINE

During periods of industrial depression a struggle for existing business is very naturally induced, which results in prices trimmed so close that there is little or no profit in handling the work. Business of this class, however, serves to keep together for future increase a force of men trained in some particular line of work, and for such purpose is self-justifying.

In an ambitious attempt to transfer some of this competition type of work into profitable business the "square cornering" tool, shown in the engraving, was evolved. We had a large number of flat castings ¾ inch thick, with a rectangular opening 12 x 15 inches, the sides of which had to be machined straight and square with each other. As the speed of the cutters limited the time consumed in milling the sides, any reduction in manufacturing cost had to be made by cutting the time between, or rather after, these cuts had been taken. Therefore it was desirable to remove the sections left in the corners by the straddle mills as quickly as possible. The device by which this was done was simply an auxiliary arbor suspended below the regular arbor and driven by spur gearing. The castings were clamped on parallels, as in slotter work, and passed across the cutter by the elevating screw. This was a lighter task than would at first appear, for the weight of the knee formed a hold-back that permitted the work to be fed *into* the cutter, which, in turn, materially assisted in lifting the weight by its upward movement. This device turned out ten complete castings, or forty corners, in one hour, using a carbon steel cutter. DONALD A. HAMPSON.

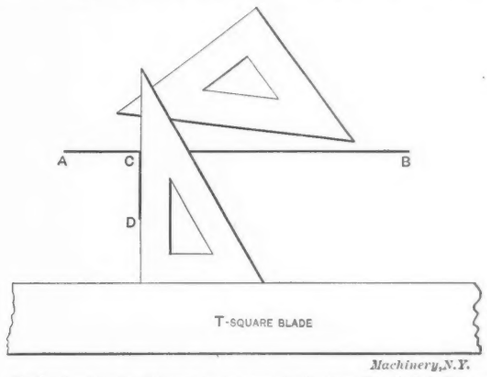


Cornering Tool attached to the Milling Machine and Example of its Work

Middletown, N. Y.

TO AVOID BLOTTING FRESH INK LINES

It sometimes becomes necessary for the draftsman to draw short vertical lines before the horizontal ink lines are dry, and it is impossible to lay the triangle on them without causing a blot. The lines can often be drawn by laying one triangle over the other, to lift it off the paper, as shown in the sketch, where the line *A—B* is supposed to be a freshly inked line, and it is desired to draw the line *C—D* without waiting for *A—B* to dry. One triangle can be laid on the board just above *A—B* with one edge approximately parallel to it. Then the upper end of another triangle can be laid over the first, its lower edge being guided by the T-square blade in the usual way. This lifts it clear of the line *A—B*, and *C—D* can be drawn just about as well as though the triangle were flat on the paper. WALTER GRIBBEN.



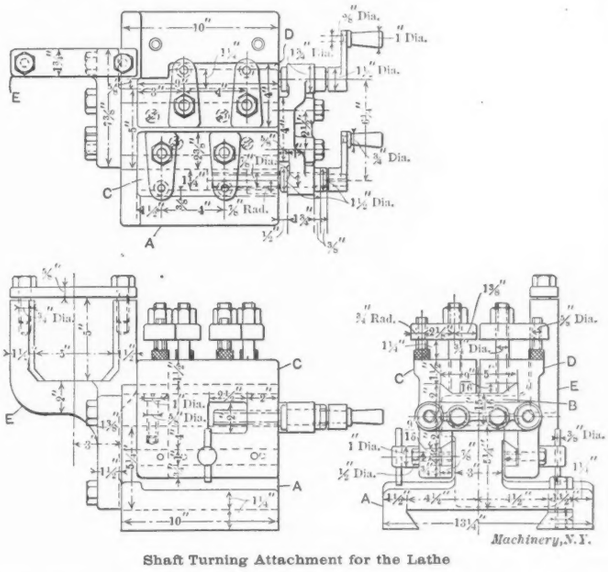
Machinery,N.Y.

Method of using Triangles to avoid Blotting Fresh Ink Lines

Brooklyn, N. Y.

A SHAFT TURNING ATTACHMENT

We recently had to supply a three-tool rest for shaft turning which had to fit onto a lathe which was used for practically any job that came along, and as shafting seemed to come along pretty often, it was thought advisable to provide some means whereby this kind of work could be more economically dealt with. It was desired that the attachment be so designed that little time would be required in changing from shaft turning to ordinary work and *vice versa*. The device consists of a base *A*, which in operation is securely clamped to the cross-slide of the lathe; a slide *B* on which tool-holders *C* and *D* work, and a stay *E* which carries either metal or hard wood steadies for supporting the work. The slide *B* is made separate from the main casting



Shaft Turning Attachment for the Lathe

A so that the bearing surfaces may be more easily machined and scraped to fit. It will be seen that the tools come quite close together and yet plenty of room is left for the handles which work the screws for adjusting each tool.

In operation the ordinary tool rest of the lathe is moved to the back of the carriage and the two-tool rest mounted on the front. The back rest carries the roughing tool which is, of course, clamped with the cutting edge downward. The left-hand tool-holder of the attachment carries the first finishing tool, while the right-hand one carries the finishing tool proper. All three tools are under perfect control from the operator's working position in front of the lathe (the back tool is, of course, adjusted by the regular cross feed screw) and when the lathe is needed for work other than shaft turning, five minutes, at the most, is all that is required to dismount the shafting attachment.

I might say, in conclusion, that with this arrangement a feed of 1/32 inch per revolution of spindle leaves a fairly good finish which only needs polishing to meet ordinary requirements. A good stream of lubricant is required on the tools, particularly if high speed tools are used. RACQUET.

SWINGING INK-BOTTLE HOLDER FOR DRAWING TABLE

Experienced draftsmen know the risk in keeping the ink bottle on the drawing board, especially if it be a sloping board. Even when the bottle is fastened in a heavy base to avoid tipping over, it may slide off the board, or ink may

Fig. 1. Holder for Two Ink Bottles, which is easily swung out of the Way

be dropped on the surrounding board or paper when filling the pen, and anyway it is in the way and takes up space on the board. To avoid these difficulties, I designed and had applied to several drawing-tables the device shown in Fig. 1, which has been found very satisfactory and convenient. The

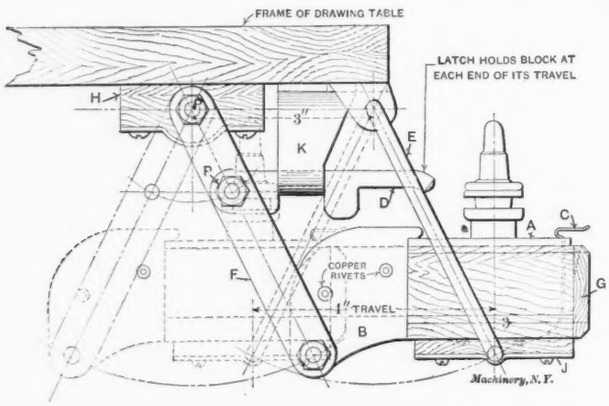


Fig. 2. Side Elevation of the Holder, showing the Inner and Outer Positions

line illustrations, Figs. 2 and 3, show the construction with certain improvements over the original design shown in the half-tone.

The device illustrated may seem to have a great many parts, as compared, for instance, with a drawer, which is the first thing one would think of for the purpose; but a drawer on this folding drawing table would have been in the way, and a slide of ample length would have required more depth than was here available. This holder is located next to the left side of the draftsman, and in the half-tone it is shown pulled out, affording ready access to either of the two ink bottles which are locked fast in it, and requiring one hand

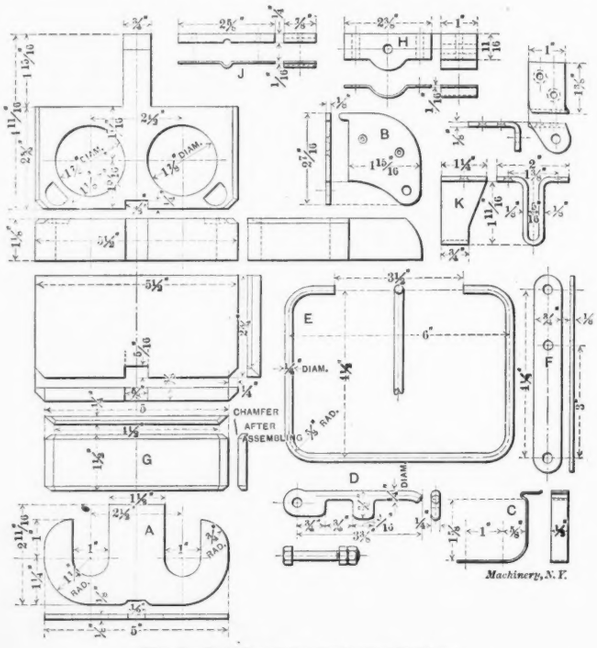


Fig. 3. Details of the Swinging Holder

only for removing the filling quill. The bottles may be quickly removed for changing or renewing, by unscrewing the one thumb-nut and removing the brass retaining-plate *A* (Fig. 2), the back edge of which slips into the recess in the wooden strip at the back. In the improved design this wooden strip is done away with, as is evident in the line drawing, ears being formed on the plates *B*, instead; also the thumb-nut and screw have been superseded by a spring clip, *C*, making it still easier to remove the bottles.

After inking the pen, lifting the latch *D* with the tip of the finger enables the holder to be instantly pushed back out of the way; at the back end of the stroke the latch drops into place again and the swinging holder is retained there, entirely underneath the table and out of the way. The construction should be clear from the drawings, the marks or symbols used being the same in Figs. 2 and 3. The wooden parts of the holder are glued together, other fastening being afforded by the wood screws and the rivets indicated in the assembly drawing, Fig. 2. The portion of the drawing table to which the holder was attached is permanently horizontal, the drawing board, of variable slope, being pivoted above. Attachment was made by 8 wood screws; of course, if desired it could be all attached to a separate block, permitting, in the event of shipment, removal without disassembling.

Berkeley, Cal. H. J. KENNEDY.

HOSE COUPLING AND CLAMP

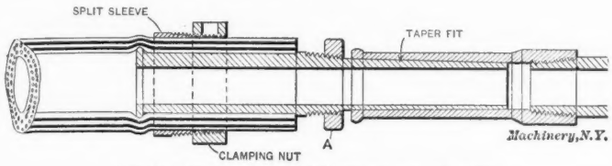
There are a great many different styles of hose couplings on the market, but still there seems to be room for improvement. No matter how careful the operators of pneumatic tools are, there is always a certain amount of time lost because couplings slip out of their hose or because the quick-adjusting types become disconnected. This trouble may be caused by poor construction and partly by rough handling.

The accompanying engraving shows a quick-adjusting hose coupling and also a hose clamp, that are giving satisfaction.

This coupling has a taper of 1/32 of an inch in 3 inches, which is very gradual, and when the parts are connected with a quick jar the taper "bites" so that they seldom come apart. When the coupling is to be disconnected, the parts are twisted by placing a wrench on the nut *A* provided for

that purpose. This takes time, but it is well spent as most couplings that can be taken apart by hand are generally leaky or very liable to come apart with the pressure on, and possibly cause an accident.

The hose clamp shown, is made of brass tubing. It has a 16-pitch taper thread cut on it and is split with a hack-saw in about six places. A knurled nut is also provided which is drilled for a round spanner, for tightening. As the nut is screwed on the taper thread, the tube takes a firm grip on the hose, which, in turn, is compressed against the inside connection or coupling.



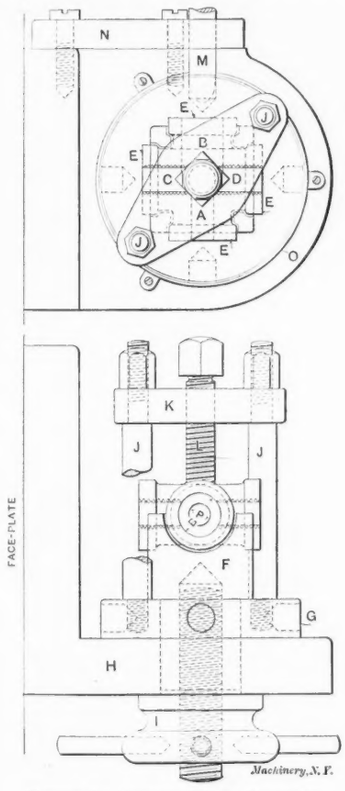
Simple Form of Hose Coupling for the Air Hose

This clamp has no extending parts such as screws, bolts or lugs which are usually found in hose clamps, to catch, as the operator pulls or drags the hose along the floor or ground. The hose couplings on one end are either made to screw on a nipple or be clamped in a hose. It will be found quite profitable in a large works to have patterns made and then cast the parts of brass as the occasion demands, rather than to buy and experiment with couplings of various kinds.

R. S. F.

TURRET LATHE FIXTURE WITH INDEXING ATTACHMENT

In the accompanying engraving is shown a fixture for facing, drilling and tapping the knuckle in a universal joint. This fixture, when in use, is mounted on the face-plate of a turret lathe, and with it the several operations are done very rapidly and at one setting of the work. These knuckles must be interchangeable, as they are used for repairs. They are made of malleable iron, and it is necessary to face the four sides *E*, drill holes 3/8 and 9/16 inch in diameter at *A* and *B*, respectively, and drill and tap the holes *C* and *D*. The castings are located in the fixture in the correct position by the holder *F*, the top surface of which is made to conform to the four flanges, there being clearance for the body of the casting. The holder *F* is made a press fit in the steel ring *G*, and the protruding end is made a sliding fit in the angle-iron *H*. Tapped into *F* is a stud on which the clamping-wheel *I* is mounted. Two tie-rods *J* are screwed into the plate *G*, and at the ends of these rods there is a strap *K* through which passes the clamping screw *L*. In the ring *G* four holes are drilled to receive the index pin *M* which is mounted in the arm *N*. This pin is held in place by a spring not shown. In the illustration the fixture is shown with the work in place, machined and ready to be taken out, which is done by simply releasing the clamping screw *L*. The changes are made for the different holes by releasing the clamp-nut *I* and withdrawing the index pin, after which the work can be turned to the desired position, the index pin locating the chuck while it is being clamped by the nut *I*. To prevent any dirt or chips from working into the index holes, a band of brass *O*, having a hole for the index pin, is placed around the ring *G* and fastened to the angle-iron. This fixture can be used for more than one class of work, as the holder *F* can be removed and replaced with one of a different shape and size.



Fixture for Universal Joint Knuckles

C. A.

OBTAINING DIAMETERS WITH A BEVEL AND SCALE

That diameters may be obtained by the use of an ordinary bevel and scale, is perhaps not as well known as the advantage of this method merits. Of course, these tools are only used when it is impossible to caliper the piece, as would be the case were it necessary to determine the radius of the

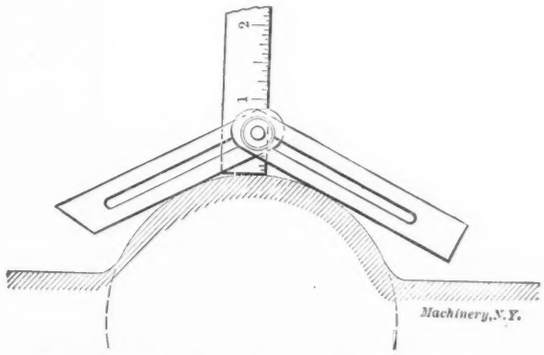


Fig. 1. Method of applying Bevel and Scale to Work which cannot be Calipered

cylindrical surface shown in Fig. 1. In order to obtain a diameter with the above tools, the bevel must be set to a certain angle previously determined, which corresponds to the graduations on the scale; then the diameter can be read directly from the scale. For example, if the bevel is set to an included angle of 125½ degrees, as illustrated in Fig. 2, and the distance *x* from the surface to the apex of the angle is measured with a scale, as shown in Fig. 1, the diameter may be readily determined, for it will contain as many inches as there are sixteenths of an inch in the distance *x*. Thus, if *x* equals ¼ inch, which is equivalent to four sixteenths, the diameter would equal 4 inches. When the bevel is set to 140½ degrees, each 1/32 inch represents an inch of diameter; 142¾ degrees, each 1/10 inch; 106¼ degrees, each ⅛ inch; 83⅝ degrees, each ¼ inch; 60 degrees, each ½ inch.

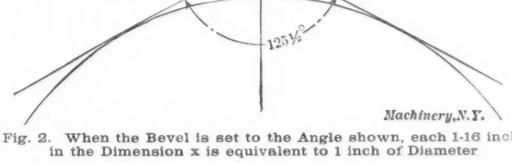


Fig. 2. When the Bevel is set to the Angle shown, each 1-16 inch in the Dimension x is equivalent to 1 inch of Diameter

It will be noticed that the less the angle the greater the distance representing inches becomes, and consequently the smaller the range of diameters which can be obtained. Thus, if the angle is set at 60 degrees, each half inch on the scale will represent an inch of diameter, and accurate fractional diameters can be obtained; but with this angle a large diameter could not be measured, and it would be necessary to use the bevel set at a greater angle.

A carpenter's square can also be used to obtain the same results, but a little calculation is necessary to get the diameter. After measuring the distance *x* with a scale, as explained, it must be multiplied by 4.83 in each case where an included angle of 90 degrees is used. Thus, if the distance measured 4 13/16 inches, the decimal equivalent to 13/16 should first be found, and the number 4.812 multiplied by the constant 4.83. The result would be 23.242 inches, which represents the diameter. As before stated, this method is

intended to be applied to inaccessible diameters, but it can often be used to advantage for measuring pulleys, etc., which are too large to permit the use of calipers.

C. E. J.

LARGE COMPACT DRAWING-BOARD

At the present time many shops are figuring on propositions which require large layouts, and the ordinary drawing-boards are far too small; yet conditions do not warrant the purchase of a large outfit or perhaps there is no room avail-

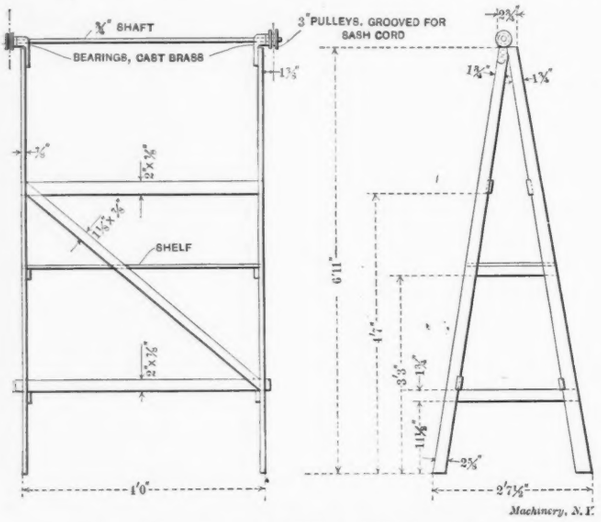


Fig. 1. Elevations of the Drawing-board Frame or Easel

able, and to meet the conditions requiring large capacity and minimum floor space, the board here shown has been built. It proved so useful that a second one was asked for and both are now in constant use. The frame, or easel, as artists would term it, is shown in Fig. 1. Only general dimensions are given, for such details as placing screws and making joints can be decided by the workman. The shaft, pulleys, and bearings, shown at the top, carry the counterweights needed to balance the drawing-board. Fig. 2 shows the general dimensions of the board and straight-edge. The board is built of ¾-inch stock in the usual manner, with a brace at each end and one in the middle. The end braces also act as

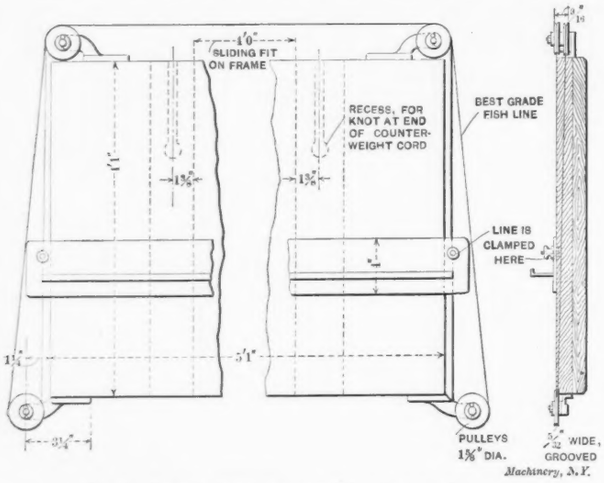


Fig. 2. Detail of the Drawing-board and Straight-edge

guides, their centers coming in line with the center line of the pulleys on the shaft shown in Fig. 1. A 25-pound window-weight at each end serves as a counter-balance for the board which is thus easily raised or lowered.

The straight-edge requires care in making, as both the upper and lower edges should be parallel. The projecting shelf is intended primarily as a brace but it is also very handy for holding tools. By means of the line and small pulleys, shown in Figs. 2 and 3, the straight-edge is moved and kept in a parallel position at every point, the line being clamped at each end of the straight-edge by a brass screw and nut. The straight-edge is counterbalanced by a weight of cold-rolled steel hung from a cord attached just above the brass clamping nut.

The material used was as follows: 25 feet of pine, 15 feet of white wood, 2 pounds of brass used in the small pulleys and bearings, 53 pounds of cast iron in the drawing-board counter-weights and large pulleys, 4 pounds of cold-rolled steel 1 inch in diameter for the straight-edge counter-weights, 7 pounds of cold-rolled steel ¾ inch in diameter for the shaft at the top of the frame, 25 feet of window cord, 35 feet of best quality fish line, and 3 dozen wood screws.

The time required to build this board depends, of course, on the skill of the workman. About 25 hours seems to be a good average time, a large part of which is spent in gluing the board. Foreign engineers say that this type of board is very generally used in Europe, and while at first sight a designer will usually disapprove of a vertical board, a few hours trial will prove its merits.

RALPH W. DAVIS.

Rochester, N. Y.

TOOL-ROOM CHECK SYSTEMS

I have read with considerable interest the articles dealing with checking systems for tool-rooms which appeared in the numbers of March, May and July. The various systems which were mentioned each has its merits and its defects as will any system, for keeping account of tools or supplies of any kind, which depends upon human care and intelligence for its operation. The efficiency of the system will also vary directly with the quality of the care and intelligence employed.

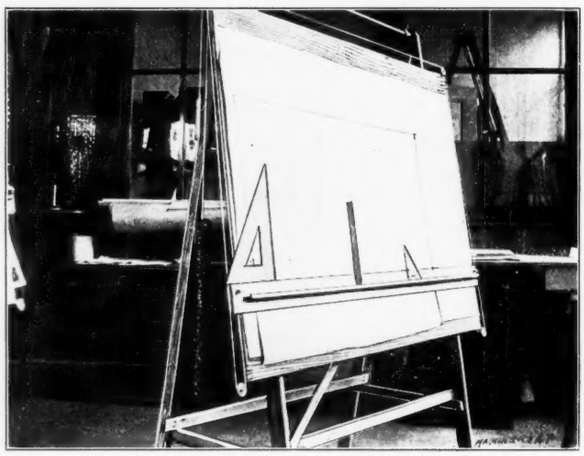


Fig. 3. Compact Drawing Board having Independent Vertical Adjustments for Board and Straight-edge

It is not my intention to put forth a better method of checking tools taken from the tool-rooms, but merely to call attention to another method which has recently come to my notice and is in operation and giving satisfaction in a large railroad shop in the East. This system consists of giving the checks to the tools instead of to the men, and it is operated as follows: A board large enough to accommodate the names of all the men who are to be served with tools, is placed in the tool-room in a location convenient to the man in charge of the distribution of the tools. Opposite each name is a hook upon which the checks are hung. The tools are numbered and the checks are also numbered to correspond. When, for example, John Jones calls for a 1-inch reamer which is number 27, the reamer is taken from its case and the check number 27, which is on a hook at the side of the case, is hung on the hook opposite John Jones' name on the board. Upon the return of the reamer the operation is reversed. The shop in which this system is in use, adopted it to overcome the trouble that was being experienced by the men losing checks and to put the prosperous check-borrow sharks out of business.

I am of the opinion that the system could be improved by supplying each man with a certain number of checks, keeping them upon a hook opposite his name on the board and exchanging one of these checks with the tool check when a tool

was taken out. This would be practically a debit and credit system of checking. Another road which uses the system of giving the checks to the men, provides for their loss by placing a value of 25 cents upon each check and deducting this amount from the man's wages for each check that is lost.

Chicago, Ill. G. E. RYDER.

The following system for keeping a record of the tools which the workmen use and which are regularly kept in the tool-room, will be found to give entire satisfaction, both to the workmen and management. It consists of two boards, each with a number of hooks equal to the number of workmen to be served. The hooks are numbered in consecutive order. On one board which is the *in* board, a number of tool checks are hung on each hook; in this case ten. The other board is the *out* board. The system operates as follows:

Every workman, when employed, receives an identification number corresponding to his number on the time recorder. Every tool kept in the tool-room is identified by a small pasteboard check, which is kept with the respective tool. Now if a workman desires a tool he presents his identification number at the receiving window. The tool-keeper hands out the tool, transfers the tool check corresponding to the number of the workman from the *in* board to the *out* board, and on the same hook hangs the check identifying the tool. It is very obvious that, through this simple system the tool-keeper is always able to tell what tools are out, and who is using them. By keeping the tool checks in the tool-room none are lost, or carried away. When a man quits, or is discharged, he must present a receipt from the tool-keeper to the timekeeper, showing that his account with the former department is in order, before he can receive his pay. This system is very easy to install and requires but little effort to operate.

Peoria, Ill. JOHN M. KUPEL.

SIMPLE FIXTURES FOR MAKING WORMS AND WORM GEARS

In Figs. 1 and 2, at *A* and *B*, respectively, are shown a single thread brass worm and a worm gear which were made in the fixtures also shown in these illustrations. As the requirements did not demand great accuracy, the worms were turned in a screw machine and the threads cut on a hand milling machine, while the gears were punched out of flat stock and then hobbed.

The thread milling fixture (Fig. 1) has a plain block of machine steel through which a hole is bored which will just admit the worms. A part of the top of the block is removed, so that the periphery of the worm is exposed, as shown. The end view shows that the worm is held true from all sides by the walls of this block. The mandrel *E* is fitted so that it turns snugly in the hole already mentioned. In one end of the mandrel a hole is tapped to receive the screw *F*, which holds the worm firmly against the end of the mandrel. On the mandrel a thread is cut, as shown, with the same pitch as that required for the worm. Instead of the nut ordinarily used on such fixtures, a plain key *G* is used. One end of this key is filed to fit into the thread on the mandrel, the sides of the tongue being left flat. It is hardened and driven into position in the block. In the illustration the pin is seen to extend from the block. This exposed end can be gripped in a vise if necessary to adjust the tongue properly into the thread on the mandrel.

An ordinary lathe dog is used to turn the mandrel in the block and feed the worm against the cutter. If, when the cutter comes into contact with the work, the worm tends to turn, such tendency is checked by the screw in the end of the mandrel, which tightens.

The cutter is ground to the standard 29-degree angle for the job. As the milling machine with which this fixture is used, has a hand lever to move the table, it is easy to bring the work up to the cutter. The table is held against a stop while the thread is being milled.

Before hobbing, the gears are gashed on the milling machine already mentioned, in lots on a special mandrel. The hobbing fixture is shown in Fig. 2. The body is of cast iron and is made of a discarded punch holder. Into this body is fitted a post, *D*. This post has a vertical adjustment, and it is held by the set-screw shown. On the top of the post there is a shoulder on which the gear is placed for hobbing. The washer *C* is held tight against a second shoulder by the nut shown. Just enough clearance is allowed to permit the gear to turn when it is driven by the hob. The hob is used on the centers of a small lathe and is driven by an ordinary lathe dog. The hobbing fixture is mounted on the cross-slide from which the tool-post has been removed.

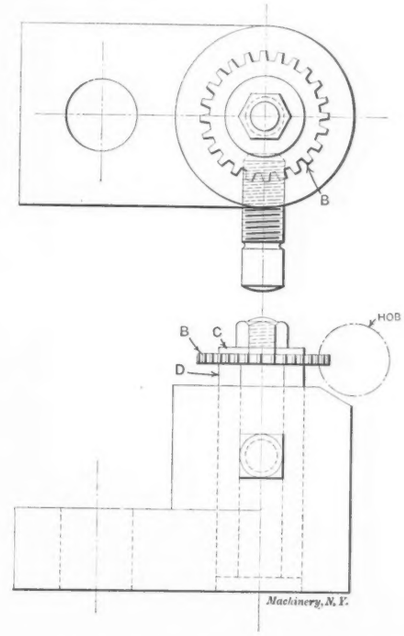


Fig. 2. Fixture for Hobbing Small Worm Wheels in the Lathe

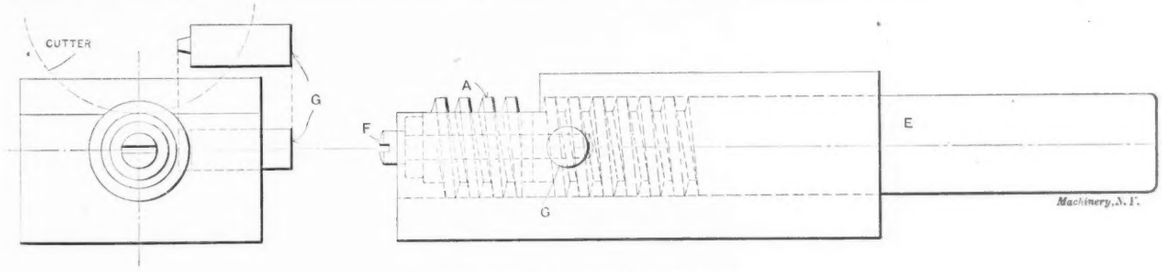


Fig. 1. Fixture for Milling Small Worms

It was found necessary to aid the hob by turning the gear with the thumb when beginning the cut, but after the gear had made one turn, the hob finished the work without further assistance. The gear was advanced toward the cutter by turning the cross-slide feed-screw. HERBERT C. BARNES.

Brooklyn, N. Y.

* * *

A side light on methods of computing charges for job work that may be useful is the practice followed by a country printer: For composition he charges two times the labor cost; for press work two times the labor cost plus 25 per cent; for illustrations, paper, etc., the charge is the cost plus 10 per cent; and all other work involving labor is charged two times the cost and 10 per cent.

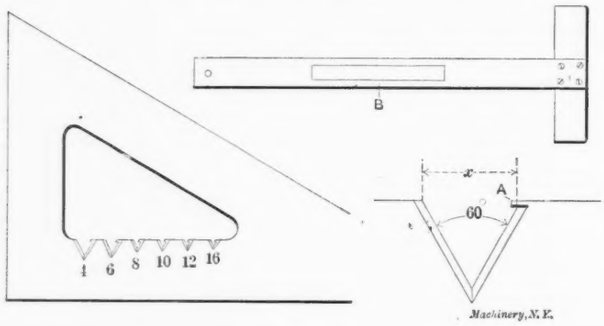
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary

DRAWING OF V-THREADS

I found the drawing of V-threads to be very trying until I thought of the following scheme which makes this work much easier. The idea is as follows: File a number of 60-degree notches in the inner edge of the triangle, as shown in the illustration, for different thread pitches. Make the top width x equal to 1 divided by the number of threads per inch, and leave a small point A to stop the pencil. To use the triangle,

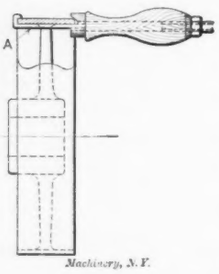


place the pencil against the left side of the notch and run it down that side and up the other to the stop; then move the triangle to the right until the pencil is again against the left side. By repeating this operation as many times as is required, a uniform thread can be rapidly drawn. Another suggestion for draftsmen is to have a 12-inch scale fastened to the T-square as shown at B. This is also a time-saver, as the scale is in a position where it is always ready for use.

Plainfield, N. J. JOSEPH WEANER.

REMOVABLE PULLEY HANDLE

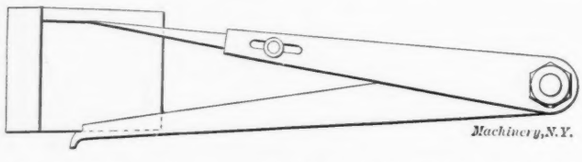
When a new machine is being built it is often necessary to revolve the feed or other pulleys by hand in order to observe the working of the machine. The removable handle shown in the engraving is extremely useful, as it may be attached to the rim of the pulley which is to be turned, thereby making the operation easy. The hook-bolt A passes under or over the pulley rim and through the handle, and is secured by a nut, as shown. The bolt is made long enough to suit various widths of rims and the ferrule is notched to grip different thicknesses. For pulleys with flanges another type of handle may be used in which a hoop-iron strap passes around the rim of the pulley, the handle being attached to the hoop iron.



BRUM.

NEW STYLE OF HERMAPHRODITE CALIPERS

The illustration shows a pair of hermaphrodite calipers, which seems to me to be an improvement, at least for a large class of work, over the style generally used. As will be seen the notch in the end of the caliper leg makes it much

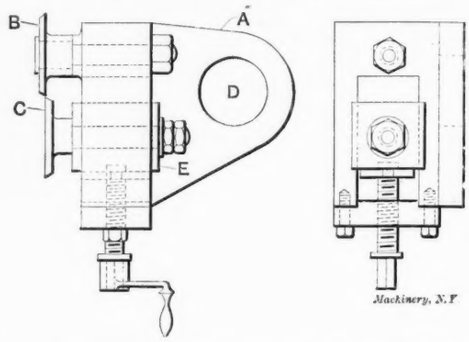


easier to scribe a line parallel with a finished edge, since the point of contact which this leg makes with the finished surface as the calipers are drawn along, is kept the same. The curved extension will also be found useful in laying out work.

Dayton, Ohio. J. L. MARSHALL.

TOOL FOR TRIMMING THIN TUBING

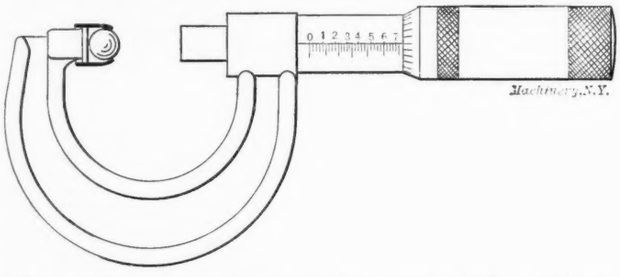
We had a number of large, drawn steel shells of about 26 gage, that had to have the ends trimmed. The metal was too thin to permit the use of a single cutting tool in the lathe, so a tool similar to the one illustrated herewith was made. It consists of a cast iron frame A, and two cylindrical cutters



B and C. The hole D through the casting A fits the tool-post of the lathe, and the fixture is clamped by passing a piece of steel through the tool-post and tightening it against the casting. Cutter B is free to revolve on a fixed stud, while cutter C is carried in a sliding box E, thus permitting it to be fed in toward B by the handle shown. When trimming the end of a tube the tool is set so that the cutter B just touches the inner side of the shell. Cutter C is then fed against the outside, and the tool makes a clean smooth cut. W. ALTON.

A MICROMETER ATTACHMENT

The engraving shows an ordinary micrometer with an attachment for measuring the thickness of metal shells or other irregular pieces of metal. A piece of brass tubing is reamed out to make a sliding fit on the anvil of the micrometer.

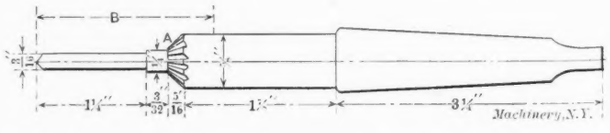


This tubing holds loosely a ¼-inch bicycle ball, which extends beyond the end of the tube, the latter being bent over to prevent the ball from falling out. The reading, of course, will be taken from the 0.250 inch graduation as zero. Bicycle balls of this size are true to 0.0001 of an inch.

Candiac, Canada S. A. MCDONALD.

HARDENING A SMALL DRILL AND COUNTER-SINK

The combination drill, counterbore, and counter-sink shown in the illustration had, of course, to be hardened. This was rather a ticklish job as the drill is so much smaller than the counter-sink, that hardening it in the usual way would mean that the drill would be at a white heat before the large part would be cherry red. To overcome this difficulty, I obtained



a fair-sized raw potato and pressed it onto the drill up to the part marked A. The tool was then placed in a slow fire and the ⅝-inch part heated, the water in the potato keeping the small part cool. When the counter-sink was heated sufficiently, the potato was removed, thus allowing the heat to run from the large part to the drill. When all was an even cherry red, the tool was cooled and the hardening was accomplished without any difficulty. JOSEPH WEANER.

Plainfield, N. J.

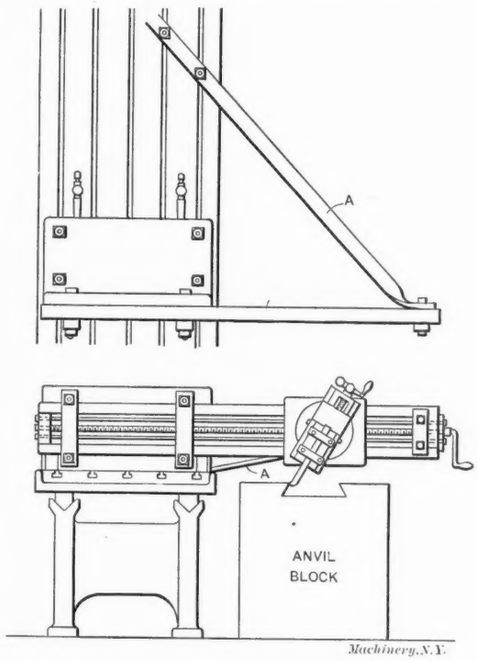
TO OBTAIN THE LENGTH OF STOCK FOR BANDS

A machinist was trying to shrink a band around the hub of a cracked pulley. He first measured the diameter of the hub and multiplied it by 3.1416 to get the circumference. The blacksmith was then told to cut off a piece of ¼-inch steel stock equal to the length of the circumference of the hub. When the band was formed to the diameter of the hub, the ends were ¾ inch apart; that is to say, they did not come together by that amount. The machinist could not understand how he had made the mistake. By the use of the following rule, trouble of this kind will be avoided: Multiply the diameter of the hub by 3.1416 and to the product add 3 times the thickness of the metal used for the band. JOSEPH WEANER.

Plainfield, N. J.

PLANING WORK THAT IS TOO LARGE FOR THE PLANER

The accompanying line engraving shows how a steam-hammer anvil-block that was too large to go on the planer, was machined. The block was first leveled up on the floor beside the planer, so that the top of the casting was a little below the top of the planer platen. For safety the casting was clamped to the floor, although its weight was such that there was no great danger of its moving under the thrust of the cut. The cross-rail with the attached head was then removed and clamped securely to a heavy angle-plate, which was bolted to the platen. A substantial diagonal brace *A* was then fastened to the cross-rail and platen as shown. The tool was fed, of course, by hand, and the dove-tail for the dies was planed by the use of the adjustable head in the usual manner. The job was satisfactory in every way and caused considerable comment in the shop. FREDERICK SEABURY.



Chicago, Ill.

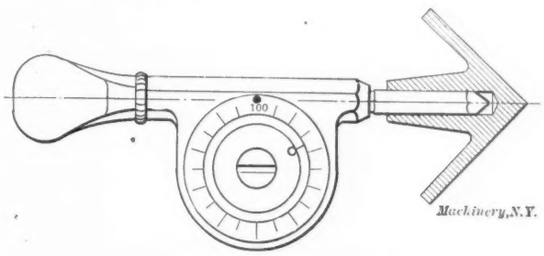
SUBSTITUTE FOR METAL WHEN MAKING ACCURATE LAY-OUTS

When making accurate lay-outs on metals, such as brass or zinc, to avoid troublesome and time-consuming calculations, I find the following objections: The needles of the drawing instruments become dull; the lines cannot be erased, and they are not very plain, especially if the metal is not coated or prepared in some manner; and the metal cannot be fastened or worked upon as easily as paper. To overcome these objections I have used as a substitute for metal what is known as filler board. This is a kind of heavy paper which looks somewhat like leather and has a mottled surface. It is often used for covers on cheap memorandum books, and is about 1/32 of an inch thick. Before lines are drawn on the surface of this board, the gloss should be removed with an eraser. The board has a good, firm body, and therefore a fine center can be made in it from which several circles can be drawn without appreciably enlarging or injuring it. Like other materials in the paper line, filler board will change slightly on account of variations in the temperature and atmosphere, and for this reason the measurements should be marked on the drawing as soon as it is made to avoid any possibility of slight errors due to changes. Where extreme accuracy is required and the nature of the lay-out is such that measurements cannot be marked to advantage, metal is advisable, especially if the drawing is to be kept for a considerable length of time as a record or for reference. H. R. ASH.

Chicago, Ill.

SPEED INDICATOR ATTACHMENT FOR SCREW MACHINE

It was necessary to determine the spindle speeds of a large number of screw machines which were operating on a wide variety of work, ranging from ¼ to 1¾ inch in diameter, and it was desired to get the speeds more accurate than would be possible by simple measuring pulleys and calculating the speeds from the speed of the line-shaft. The following method

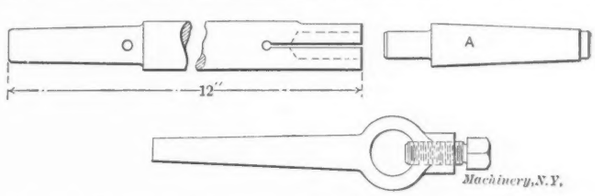


was tried with satisfactory results. An ordinary speed indicator was fitted with a brass conical tip 2 inches in diameter, as shown in the illustration. This tip was made a tight fit on the indicator spindle and was turned out to reduce the weight. To keep the indicator from slipping, three grooves 1/16-inch deep were cut radially in the conical surface and pieces of rubber peened in. In order to secure satisfactory results the indicator should be used when the feed tube is nearly empty, or just after the stock has fed into the tube; then the tip of the indicator will center in the tube and the correct spindle speed is easily taken. In this way accurate results are obtained, because there is no error due to slip of belt or variation in size of pulleys. By watching a group of machines and taking the speeds as the stock runs out, the time consumed is not as great as with the usual method of measuring pulleys and figuring from the line-shaft speed.

Indianapolis, Ind. C. C. MYERS.

ARBOR FOR SHELL REAMER

The engraving shows an arbor for a shell reamer, which is so designed that it will not creep off of the tail center and crowd into the work, as is the case when the arbor is held directly against a cone center. This arbor has a hole drilled in the end about 1¼ inch deep in which is fitted a special tail center *A*, having a straight portion about 1 inch long.



The end of the arbor is sawed through so that it grips the center when a dog is placed on it and tightened. Even without the split end there is no tendency on the part of the arbor to work off the center *A* since the upward thrust on the center (equal to the downward thrust on tail of the dog) has no horizontal component. There is also a special straight-tailed dog to go with the arbor, but this is not really necessary. The diameters of the holes in ends of all arbors are made the same. Since adopting this form I have had no difficulty with bent arbors, broken centers, broken shell reamers and inaccurate holes. W. A. KNIGHT.

Columbus, O.

HOW AND WHY

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

DESIGN OF MACHINE LEGS

C. E. F.—Is the design of machine legs based on empirical rules or theoretical assumptions? I have given the matter considerable thought and have been unable to arrive at any definite conclusion from a study of existing designs.

A.—It is generally conceded that design of machine legs which shall have a pleasing appearance and fulfill their purpose is one of the most difficult parts of machine design. There are no empirical rules of general application or theory of design that provides for grace of outline as well as proper support. The function of the legs should be that of supporting the machine and transmitting its vibrations to the foundation, especially in the case of machine tools. The tendency of modern design is to eliminate the legs entirely and carry the frame to the floor or foundation. This form avoids the troublesome feature of proper leg design and increases the solidity and rigidity of the frame by deepening it and more closely associating it with the foundation.

ANNEALING AIR-HARDENING STEEL

F. T. M.—I would like a reliable method of annealing air-hardening steel so that I can drill holes about 3/32 inch diameter 2½ inches deep, and tap same to a depth of about ½ inch. The brands of steel that I have tried are refractory, and it has been found impossible to anneal them so that the drills will stand up. I have tried a certain brand of high-speed steel drill but the results are about the same as with regular drills.

A.—We are unable to suggest any but the well-known method of annealing air-hardening steel by using air-tight receptacles in which the steel is packed with lime, sand, ashes or other neutral material; and heating the box and contents to a full red heat for a number of hours, depending on the size of the box and stock, and allowing the whole to cool down slowly. The question is referred to the readers for answers and suggestions. Many, no doubt, will highly appreciate a description of a method of annealing air-hardening and high-speed steel that is superior to the common method in use.

CUTTING SPEEDS

F. W.—Please state the proper cutting speeds for both carbon and high-speed steel tools, cutting tool steel, machine steel, cast iron and brass, in different machines.

A.—The proper cutting speed depends on several factors besides the kind of material to be cut and the kind of steel used for the cutting tool. The depth of the cut, the feed, and whether roughing or finishing, also influence the cutting speed. For general purposes the table above, however, referring to regular carbon tool steels, will be found to give figures representing good average practice. For high-speed steel tools these speeds may be at least doubled. The Cleveland Twist Drill Co. recommends for high-speed steel drills a cutting speed of 50 to 70 feet per minute for machine steel; 60 to 80 feet per minute for cast iron; and 100 to 140 feet per minute for brass, when starting the drill. When a few holes have been drilled at these speeds, still higher speeds may be employed, as the drill point is then heated and high-speed steel tools have a higher cutting capacity when heated than when cold. At the W. G. Armstrong, Whitworth & Co. works of Manchester, Eng., a cutting speed as high as 160 feet per minute for turning machine steel and 150 feet per minute for milling machine steel with high-speed steel tools and cutters, has been employed successfully.

TABLE OF CUTTING SPEEDS IN FEET PER MINUTE

Carbon Steel Tools

Machine	Material			
	Tool Steel, Annealed	Wrought Iron and Mch. Steel	Cast Iron	Brass
Lathe, planer and shaper	18 to 25	30 to 40	40 to 50	80 to 125
Milling machine	25 to 35	35 to 45	40 to 60	80 to 120
Drill press	20	30	35	60

A PROBLEM INVOLVING MOMENTS OF FORCES

B. R. E.—A window cleaner sets an eight-foot ladder weighing twenty pounds against a plate glass window with the foot of the ladder two feet from the plane of the window glass, and climbs to a height of three-fourths of the ladder's height. If he weighs 150 pounds, what is the horizontal pressure against the glass window when he stands erect without touching the glass?

A.—In the accompanying illustration, AB represents the ladder, the length of which is 8 feet; BC is the plate glass window; the lower end A of the ladder is placed 2 feet from the plane of the window. Four forces act on the ladder, *viz.:* the reaction P at the upper end, at right angles to the window plane; the weight W of the window cleaner, acting vertically downward at a point three-fourths of the ladder's height from the ground; the weight W_1 of the ladder, concentrated at its center and acting vertically downward; and the reaction R at the foot of the ladder acting vertically upward.

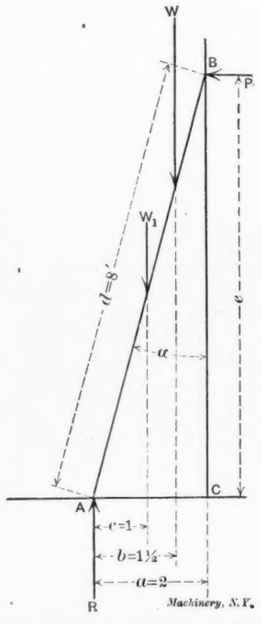


Diagram showing Forces Acting on Ladder

In order to arrive at a universal formula, let the various dimensions be represented by a, b, c and d, as shown in the illustration. To find P, find the moments of the forces relative to point A. The moment of force R relative to this point = 0. Hence, the moments of W and W_1 must balance or equal the moment of P. Therefore:

$$Wb + W_1c = Pe.$$

But $e = a \cot \alpha$; consequently

$$Wb + W_1c = Pa \cot \alpha,$$

or

$$P = \frac{Wb + W_1c}{a \cot \alpha} = \frac{Wb + W_1c}{a} \tan \alpha.$$

If we now insert the given values for the various quantities, we have:

$$P = \frac{150 \times 1\frac{1}{2} + 20 \times 1}{2} \tan \alpha = 122.5 \tan \alpha.$$

As $\sin \alpha = \frac{2}{8} = 0.25$, $\alpha = 14° 29'$. Tan α, then, is 0.25831, and

$$P = 122.5 \times 0.25831 = 31.64 \text{ pounds.}$$

This is the pressure due to the combined weight of the window cleaner and ladder, tending to break the glass.

* * *

It frequently happens that a babbitt-metal is required intermediate between the well-known genuine mixture and the cheapest grade in which nothing but lead and antimony is used. As the market price of tin is always high, genuine babbitt is often too expensive for many consumers to employ. The following mixture, given in the *Brass World*, will serve in instances where an intermediate grade is desired:

Lead	50 pounds
Tin	35 pounds
Antimony	15 pounds

This mixture has the advantage of containing no copper, and, therefore, is easily made in an iron kettle. It is not only intermediate in quality but in price as well. It is better than the lead and antimony mixtures, and is only slightly inferior to genuine babbitt. Many large machine builders now use it with good results where genuine babbitt was formerly employed.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

LE BLOND HEAVY-DUTY ENGINE LATHE

The accompanying illustrations show a general view and details of a 20-inch heavy-duty engine lathe recently placed on the market by the R. K. LeBlond Machine Tool Co., 4609 Eastern Ave., Cincinnati, Ohio. This is one size of a line of lathes of the same type, including 16-inch, 20-inch, 24-inch and 30-inch lathes. The principle on which these machines have been designed has been to furnish a tool capable of taking a given cut and removing a given number of cubic inches of metal per minute. The 20-inch lathe shown in Fig. 1, for example, is capable of taking a cut ¼ inch deep with a feed of 1/6 inch at a cutting speed of 65 feet per minute, in 50-point carbon steel. This is equal to removing 32 cubic inches of metal per minute. While the new ideas incorporated in the design of this new line of lathes do not involve radical departures from the company's previous designs, an effort has been made to increase the productive capacity of the machine in all respects. At the same time, the manufacturers have aimed to produce a machine without complicated detail arrangements, so that it would be easily operated, and remain rigid even under heavy stress.

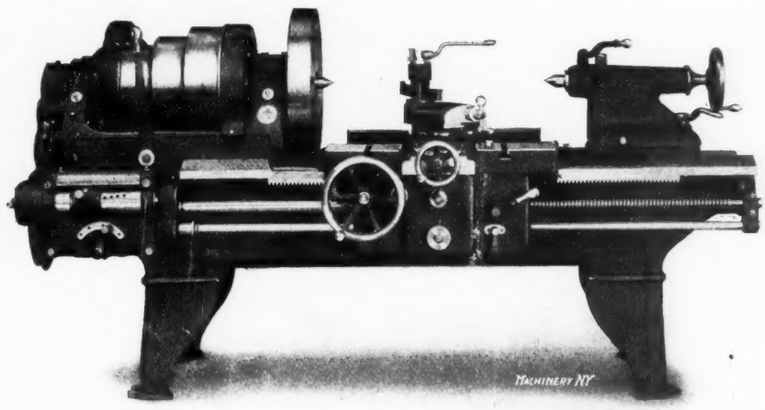


Fig. 1. R. K. LeBlond Machine Tool Co.'s 20-inch Heavy-duty Engine Lathe

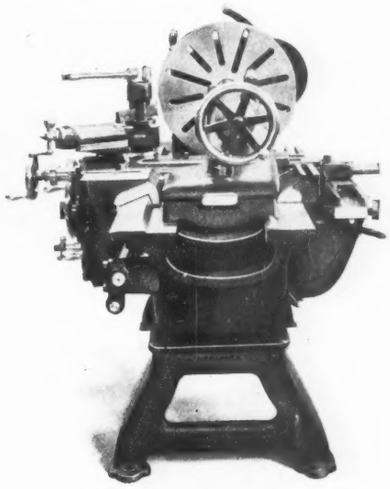


Fig. 2. End View of Lathe

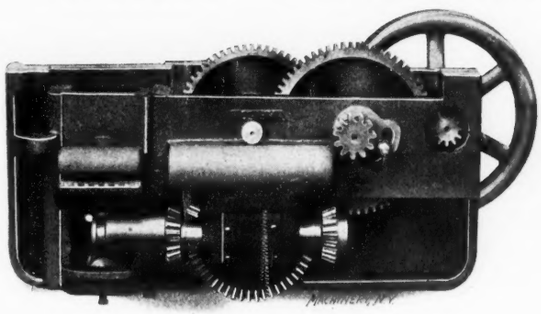


Fig. 3. View of Apron, showing Construction

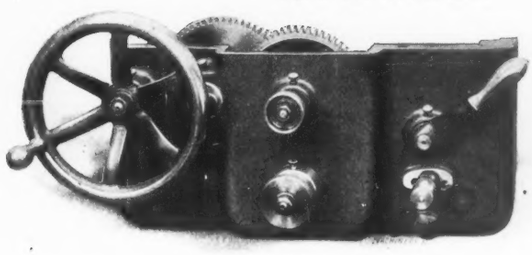


Fig. 4. Front View of Apron

The Head-stock and Tail-stock

The head-stock is of the LeBlond improved drop braced pattern and is securely fastened to the bed with bolts of large size. The three-step cone pulley in conjunction with the double friction back-gears and a two-speed countershaft, provide, in all, eighteen changes of spindle speeds, covering a range carefully selected for the purpose of the machine. The spindle is hollow and made of high carbon hammered steel, and is hardened and ground at the front and rear journals. These latter are carried in cast iron boxes scraped to a good bearing fit. This type of bearing the builders consider preferable, because it does not require intricate oiling devices with continual attention on the part of the operator; yet the lubrication is well taken care of. The bearing standards are cored out to form large oil chambers which are filled from the front of the lathe; from these the oil is fed to the bearings by means of felt pads. This construction eliminates all possibility of grit and dirt entering the bearings, and reduces the attention required to filling the oil receptacle once a week.

The tail-stock is of massive design with a bearing of ample length on the bed. The tail-spindle barrel is designed in such manner as to give the maximum length of bearing combined with long travel. Screws are provided for setting over the tail-stock for taper work, the base being graduated so that this setting can be easily accomplished.

The Bed

In the end view of the lathe, Fig. 2, the form of bed, which is a new departure, is clearly indicated. The tail-stock slides on a V of the usual proportions on the rear way, and on a flat surface in the front. The carriage travels on a flat surface in the back, as shown, and is held down in the back by a flat gib. The front of the carriage slides on a guide of different shape from that usually found in engine lathes. This guide, as shown, is V-shaped, but is machined at an angle of 15 degrees on the front side, and 70 degrees on the back, making the total included angle 95 degrees. The force exerted downward on the carriage of an engine lathe is many times greater than the upward pressure, and in designing the lathe bed this fact has been given due consideration, the wearing surfaces, therefore, having been proportioned accordingly, as shown.

The bed, in addition to having an unusually deep section, is reinforced and braced by a transverse rib of an I-beam section directly under the front bearing; this rib extends up to the extreme top of the bed. In addition to this, the metal around the holding-down bolts for the head has been reinforced to about three times the thickness usually found at this place.

The Carriage and Apron

The carriage is held in alignment on a scraped surface on the front of the bed by taper gibs at both end bearings. This

construction, together with the 70-degree angle on the back of the V overcomes any tendency of the carriage to climb the ways when the lathe is engaged on heavy work. The gibs are tongued in position in the carriage, and in combination with the special construction of the V, they automatically compensate for the wear; this makes it unnecessary to give any attention to the adjustment of the gibs. Wipers are

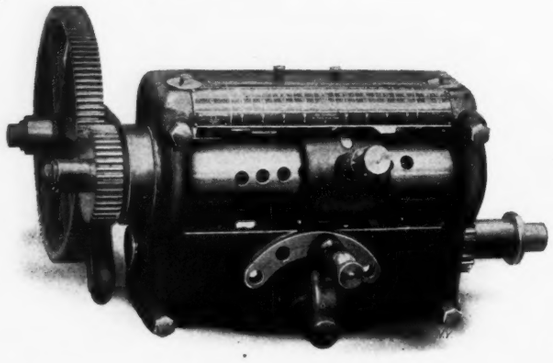


Fig. 5. Gear Box, complete, ready to be Applied to Machine

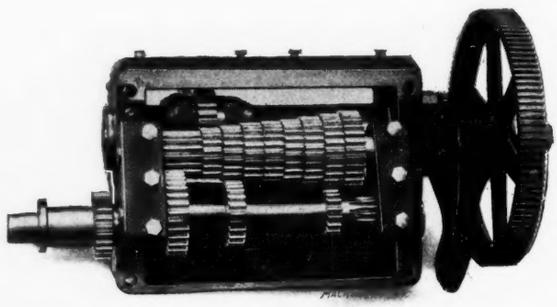


Fig. 6. Arrangement of Gearing in Gear Box

provided, fitted with felt pads, which in addition to wiping off chips and grit from the sliding surfaces also provide for automatic oiling of the ways.

The line engraving, Fig. 7, shows a cross-section through the bed, carriage, apron and taper attachment. This engraving indicates clearly the proportions of the shears, and shows also the relative position of the lathe spindle to the bed. The spindle, as will be noted, is set back a certain distance (in this size of lathe two inches) from the center of the shears, which construction not only provides for an increased swing over the carriage, but at the same time permits the machine to be used at full swing without the tool overhanging the bed, a construction which adds greatly to the rigidity of the machine when turning work of large diameters.

Figs. 3 and 4 show a front and rear view of the apron. From these illustrations it will be seen that the apron is constructed of a one-piece box section casting, with all gears and studs supported at both ends. The apron has a wide bearing on the carriage, is held in position by four bolts, and is fitted to the carriage by means of a tongue. The single box section form of the apron, it is stated by the manufacturers, does away with the necessity of an auxiliary support at the lower end of the apron, and overcomes the difficulty of uneven wear between the lower slides and the V on the top of the bed.

The longitudinal and cross feeds are operated by a single friction which, in addition to being of large diameter, is so placed in regard to the gearing that it has but a light duty to perform. The feeds are engaged by an inward or outward movement of the knob of the lever shown on the front of the apron in Fig. 4. This lever has a central position, which disconnects all gearing when the lathe is used for screw cutting. The apron is further provided with a device which makes it impossible to engage the feed rod and lead-screw at the same time.

Change Gear Box

The quick change gear box supplied with these lathes is shown in Figs. 5 and 6, the former showing the gear box ready to be assembled to the lathe, while the latter shows the gearing, the front cover having been removed. The entire mechanism is completely self-contained. Nine changes of speed for the lead-screw are obtained by means of the cone of gears shown and the tumbler. The tumbler gear, as will be seen, is supported on a cylindrical bearing, and is securely locked in position by the plunger in the change handle. This construction is the same as has been used on the LeBlond lathes for some time. The nine changes mentioned above are quadrupled by the addition of a sliding gear transmission, which is illustrated in Fig. 6. The gears of this sliding transmission are operated by the lower lever shown in Fig. 5. This construction permits of the use of a speed or index plate which reads directly, and from which the operator can see at a glance the position of the levers required for any desired speed. The changes can be made while the lathe is running under the heaviest cut. The gears in the gear box as well as all other feed gears are made from drop-forged steel blanks. The feed rod is driven by the same mechanism by means of gears connecting it with the lead-

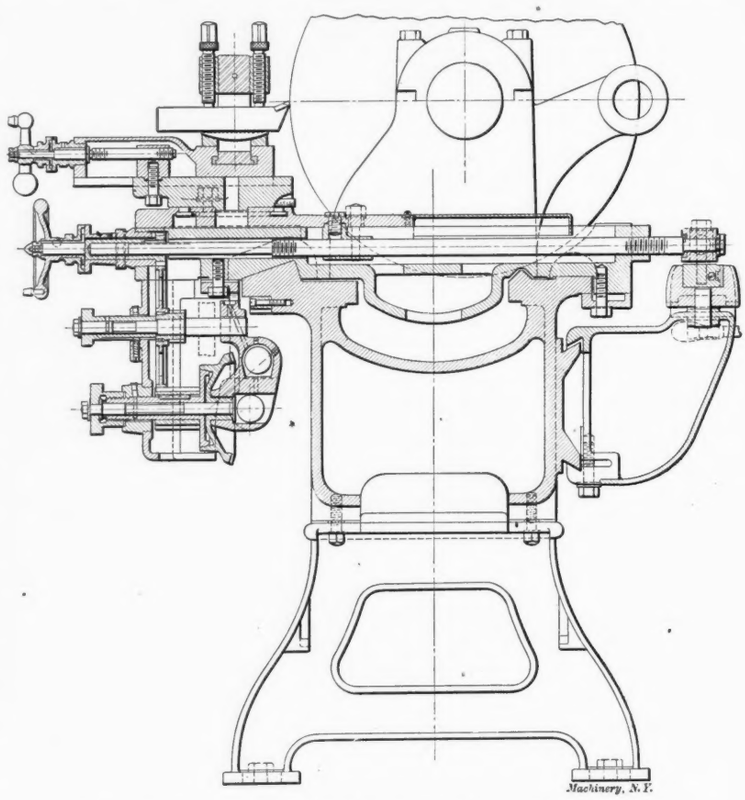


Fig. 7. Cross-section through Bed, Carriage and Apron of Le Blond Lathe

screw, the range of feed being from 8 to 120 per inch. The changes for the lead-screw provided by the gear box are thirty-six in number, ranging from 2 to 30 threads per inch.

The feed box is connected to the spindle by means of gears, the intermediate one of which is mounted on a quadrant, which permits the use of compound gearing at this point if required for cutting special or metric threads with a standard English pitch lead-screw. A metric pitch lead-screw can also be supplied, in which case the gearing arrangement permits of cutting English pitch threads with this screw, by using compound gearing in the same manner.

UNIVERSAL HORIZONTAL BORING MACHINE

A universal horizontal boring machine has recently been placed on the market by the Universal Boring Machine Co., of Hudson, Mass. This machine has been built with a special view to accuracy and permanence of alignment, and is known as the No. 2½ universal horizontal boring machine with extra long bed; this latter feature facilitates the machining of large castings. The machine is especially adapted to jig work and similar operations where it is necessary to do very accurate boring, milling and drilling, the machine itself being used for obtaining the various distances between the centers of the holes.

A general view of the machine is shown in Fig. 1. As will be seen from this illustration, the machine is of the constant belt speed gear-driven type. The bed of the machine is of a deep box construction, and is heavily ribbed on the inside to insure rigidity, which is one of the most essential features in machines of this type when accurate results are required. A heavy bed also gives a solid foundation to all the different parts mounted on it, keeping them in accurate relation to each other in all positions, and eliminating the necessity of building a foundation under the machine. Due to the fact that a foundation is not necessary, the location of the machine is not confined to the ground floor. The bed rests on three points, making it very easy to level up on uneven floors; at the same time undue strain on the bed, due to imperfect support, is eliminated.

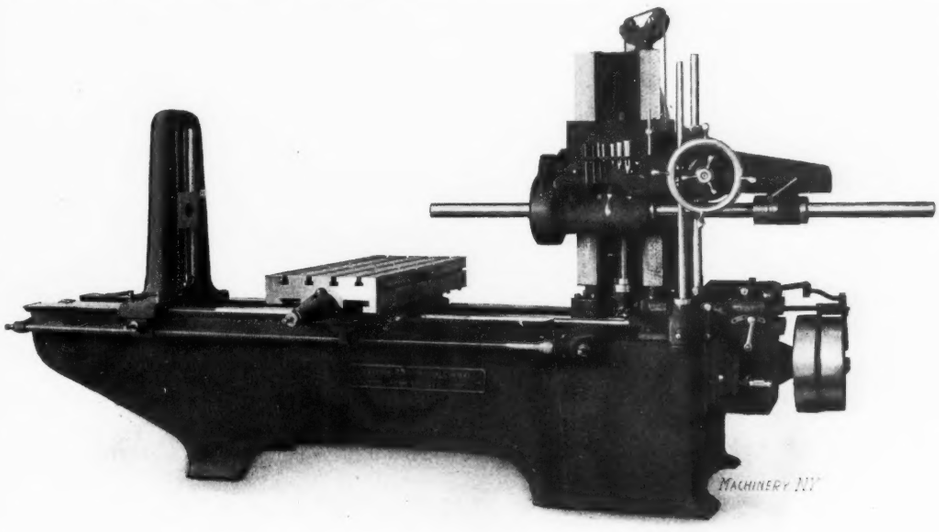


Fig. 1. Universal Boring Machine Co.'s Horizontal Boring Machine

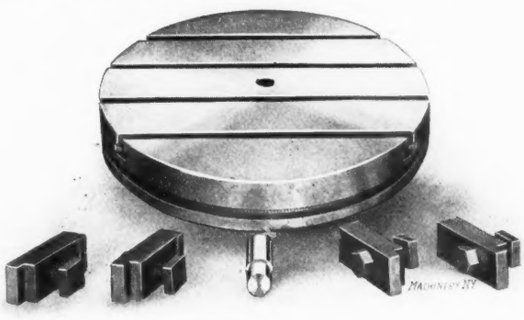


Fig. 2. Rotary Table used on the Horizontal Boring Machine

Head and Driving Mechanism

One of the prominent features of the machine is embodied in the placing of the head at the right-hand end of the machine. This arrangement permits the spindle to run in the same direction when milling as when boring and drilling. The hand-wheel for the rapid adjustment of the spindle is placed on the head conveniently in relation to the spindle where the cutter is mounted, thus allowing the operator to see the milling cutter and to make adjustments at the same time. In the line engraving, Fig. 4, is shown a cross-section of the head and the feed and speed gear box. It will be noted that the machine is provided with a power vertical feed to the head, employed when milling, which for many classes of work is a very valuable feature. Aside from the regular vertical milling feed, the head has a power feed raising and lowering device. A hand feed for fine adjustment of the head by a micrometer dial graduated to thousandths of an inch is also furnished. The head is counter-balanced by a weight attached to a wire rope, as shown, and it is moved by a large screw of coarse pitch. Suitable arrangement has been made to oil the sliding surfaces in order to minimize the wear.

The gear box, the arrangement of which is shown in Fig. 4, is strong and compact and contains both the feed and speed change gears, which are all made of steel and run in a bath of oil to provide quiet running and long wear. Eight speed changes are secured in the gear box, and these are doubled by the back gearing in the head. There are nine feed changes in either direction for the head, one lever reversing or stopping all the feeds.

The spindle is driven at a point near to the work, and thus torsional stresses are practically eliminated. This manner of driving the spindle is of special advantage when using large milling cutters, because the chatter usually present when taking heavy milling cuts on machines where the application of the drive is some distance from the cutter, is eliminated. The driving gear has a long hub in which the spindle is inserted and held by two sliding keys. The spindle itself runs in self-oiling bearings, these bearings having an individual oil compartment containing enough oil for about twenty months running. The bronze bearings, which are fitted into the bearing proper, have a groove cut the entire length, and in this groove is laid a wick having its ends submerged in the oil compartment below. The bearing proper is also split and provided with clamp screws for taking up the wear.

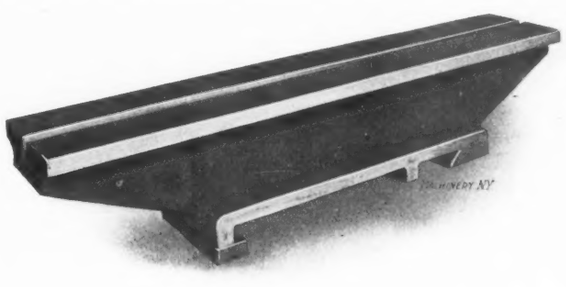


Fig. 3. Auxiliary Table used for Work which would Overhang the Regular Table

Fig. 4 also shows a cross-section of the tight and loose pulleys on the driving shaft. It will be noted that the loose pulley is slightly smaller in diameter than the tight pulley, so there is practically no tension on the belt when it is on the loose pulley, consequently there is but slight wear. The loose pulley is made in one piece and has an oil reservoir cored out around the bearing. This reservoir is filled with cotton waste and oil, and a wick is laid in a groove cut in the bearing, the ends of the wick extending downward into the oil reservoir below.

Table and Table Feed Motions

The platen or table of the machine is made especially heavy in order to avoid springing when clamping the work upon it. It is provided with power feed in either direction, and with automatic stops. The screw which imparts motion to the platen, carries a dial graduated to thousandths of an inch. The gears which drive the feed-screw are encased and run in oil. The top of the table is provided with four milled T-slots running the entire length.

The feed motion of the machine is taken from the driving shaft which runs at a higher speed than the main spindle. This arrangement, shown in Fig. 4, makes it possible to obtain nine feeds without increasing the ratio of the gearing, thus avoiding excessive stresses on the feed gears and bearings. The fine feeds are obtained by reduction gearing. Besides the table shown in place in Fig. 1, the machine is provided with a rotary table, shown in Fig. 2. This table is 24 inches in diameter and is graduated on the outside periphery to one-half degrees. The feed in both directions to the table, together with the rotary table arrangement, permit of finishing at one setting many classes of work, which would otherwise require re-setting and finishing in other machines. Holes, for instance, may be bored and drilled and surfaces milled at various angles without re-setting, thereby saving considerable time and expense in handling. In Fig. 3 is shown an auxiliary table which is used for work which would overhang the regular table. This auxiliary table has a T-slot milled its entire length as shown, and is a very essential feature in the rapid and accurate machining of large castings.

Miscellaneous Features

The outer support bearing for the boring-bars, shown in position on the bed in Fig. 1, is gibbed to the internal guiding surfaces of the support. The raising and lowering of the bearing in the support is accomplished by means of a screw connected by spiral gearing and splined shafts to the elevating screw of the spindle head, so that the two bearings for the bar move simultaneously. Provision has also been made for re-aligning the bearings in case of wear. The outer support bearing is moved longitudinally on the bed of the machine by a hand-crank. It can easily be removed from the machine, if required, by removing the bracket at the end of the bed and pulling off the supporting post, and it can be replaced in exact alignment without difficulty.

The machine is provided with extension boring-bars, and bushings to fit in the outer support bearing, and with one roughing and finishing cutter for each boring-bar. The extension boring-bars are provided with No. 4 Morse taper shanks, fitting the socket in the spindle. The spindle is provided with a slot for driving the extension boring-bars by means of two keys in addition to the usual driving tang. Two face milling cutters are also furnished with the machine, if required, one being 2 inches and the other 10 inches in diameter. The hub of the driving gear forms a face-plate to which the 10-inch face milling cutter, provided with holes for clamping screws, may be fastened. This arrangement makes the most rigid connection possible between the drive and the cutter. The smaller face milling cutter is attached to an arbor fitting the taper hole in the end of the spindle. The 10-inch cutter is provided with a center hole large enough to permit a spindle, when carrying the 2-inch cutter, to pass through it, so that either of these two cutters may be used without the necessity of removing the other.

The machine will take pieces 94 inches long between the face-plate and the outer support of the boring-bars. The greatest distance from the top of the platen to the center of the spindle is 22¾ inches. The table or platen is 20 inches wide by 42 inches long and has a cross-feed of 34 inches.

Messrs. Hill, Clarke & Co., Inc., 14 So. Canal St., Chicago, Ill., are the selling agents for this machine, and it may be seen in operation in their demonstration shops.

HOEFER DRILL PRESS WITH POSITIVE GEARED FEED

The accompanying illustration shows an improved drill press recently brought out by the Hoefer Mfg. Co., 120 Jackson St., Freeport, Ill. The most important feature in this new machine is the positive power feed and the method of changing the feed. An improvement has also been introduced in the mechanism used for raising and lowering the table arm.

As will be seen from the illustration, the drill spindle is fed downward by means of a series of gears enclosed inside of a gear box at the top of the machine, which transmit motion from the main driving shaft through a worm and worm-gear to a pinion engaging a rack on the drill press spindle sleeve. Described in detail, the motion is transmitted as follows: The horizontal driving shaft at the top of the machine carries a worm which engages with a worm-wheel keyed to a short vertical shaft. To this shaft are also keyed five gears of different sizes each engaging with a corresponding gear on a second vertical shaft. The gears in the second set run loosely on the shaft on which they are mounted, except that any one can be engaged with the shaft by means of a key sliding in a spline in the shaft and the gears. By shifting this sliding key up and down, any one of the gears in the second set can be engaged to transmit motion from the first vertical shaft to the vertical feed spindle. The motion between the second vertical shaft and the feed spindle is transmitted by means of a gear keyed permanently to the lower part of the second vertical shaft, driving a gear on the feed spindle, the latter, of course, being splined so that, while its driving gear is keyed to it, it can yet slide freely. The feed spindle carries at its lower end a worm engaging with a worm-gear keyed permanently to the short horizontal shaft

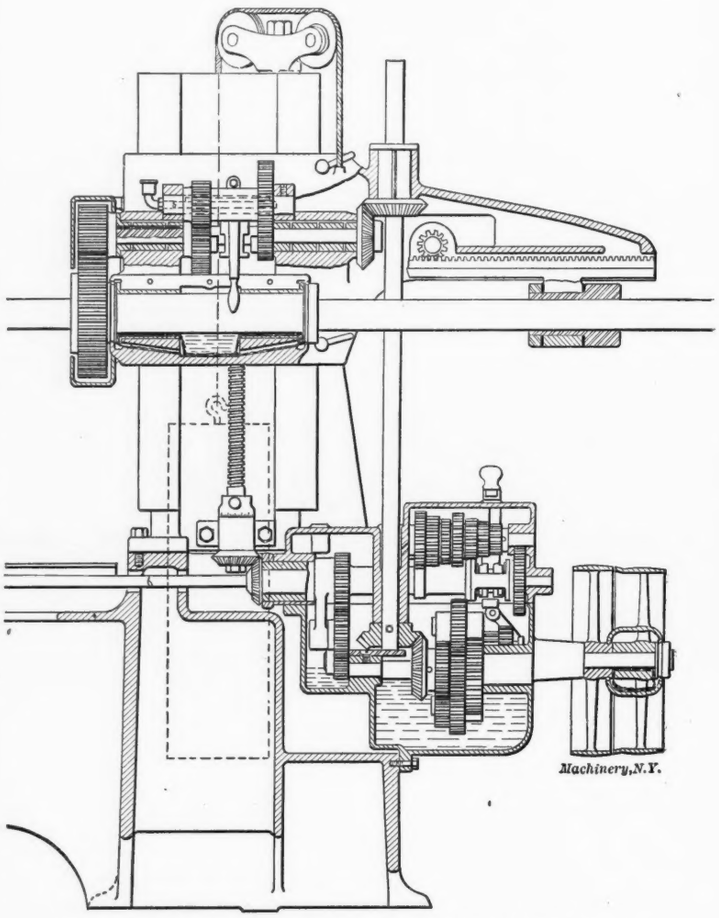
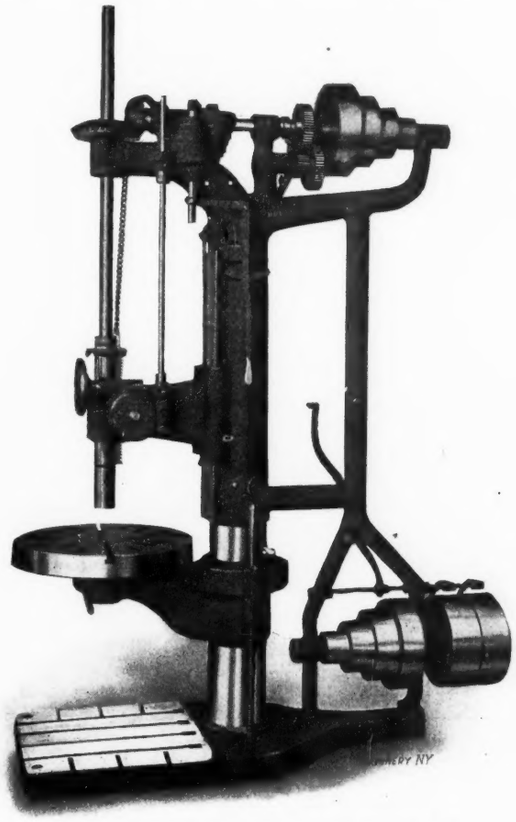


Fig. 4. Section through Head and Gear Box of Universal Boring Machine

which carries the pinion engaging with the rack on the spindle sleeve.

By shifting the sliding key up or down to engage with the different gears in the gear box, as already mentioned, the amount of feed per revolution of the main spindle can be adjusted as desired, five feeds of 0.006, 0.015, 0.023, 0.032 and 0.041 inch per revolution, respectively, being obtainable. The feed can be changed while drilling, by merely moving the lever operating the sliding key. The lower end of the key is attached to a collar on the second vertical shaft, previously mentioned, and the horizontal arms of the bell crank lever engages with this collar. The handle of the vertical arm of the lever is within easy reach of the operator, as shown in the



Hoefer Improved Drill Press with Positive Geared Feed

engraving, and by shifting it to various notches on the projecting boss on the side of the column of the machine, the feed is easily adjusted to any predetermined amount. The design prevents the key from engaging with two gears at once, as this would obviously cause damage to the mechanism. For this reason, a hardened tool steel ring is placed in a recess on one side of each gear, and as the key slides past this ring, it is forced back into the keyway in the shaft and out of engagement with both the gear that is being disengaged and the gear that is to be engaged. Continued movement of the sliding key will bring it into engagement with the next gear. In order to obviate any unnecessary loss of time, three keyways are provided in each gear so that the engagement is practically instantaneous.

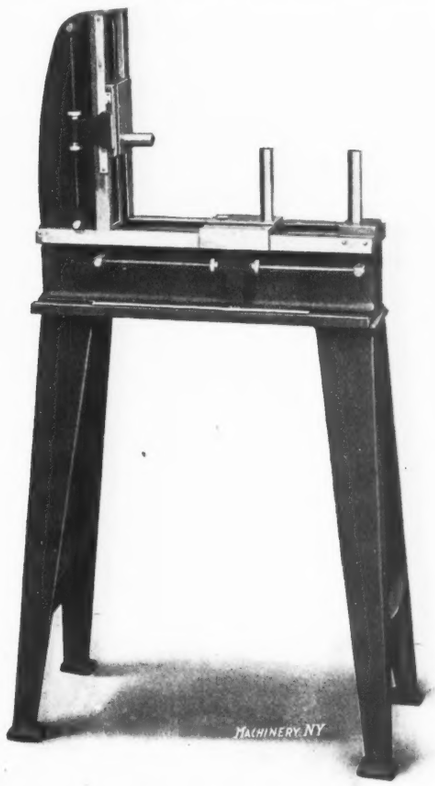
Returning to the feed mechanism on the sliding head of the machine, it should be noted that the drill or tool used can be fed by three methods, viz.: by a hand lever, by the hand worm feed, or by the power feed just described. The hand worm feed is thrown into engagement with the worm-wheel by an eccentric, while the power feed is thrown into engagement by a cam, the cam lever and eccentric being so interlocked that the engagement of both worms with the worm-wheel at one time is impossible. When passing into or out of engagement, the vertical power feed spindle swings through a small arc, but is in true alignment when in the driving position so that there is perfect mesh between the small gear by which it is driven and the driving gear on the second change gear shaft. A stop is provided by means of which the feed can be thrown out of mesh automatically at any desired point.

The improved feature for raising or lowering the table arm consists of a screw passing through a nut so arranged that it bears equally against both sides of a circular slot in the table bracket. When manufactured each machine bores the hole in its own table arm and the circular table is turned to fit the socket in the arm exactly, so that an accurate and rigid bearing is provided and, at the same time, perfect alignment of the spindle and table is assured.

The horizontal driving shaft at the top is fitted with back gears having a ratio of 4 to 1, the back gears being thrown into and out of engagement by an eccentric, as usual. The machine can be either belt or motor driven, but in either case, the driving speed can be changed, in addition to the speed change by the back gears, by means of a pair of four-step cone pulleys. The brace support at the outer end of the pulley shaft gives additional rigidity to the machine. The greatest distance from the spindle head to the base is 56 inches, and the greatest distance from the top of the table to the spindle head, 45 inches. The distance between the column and the center of the spindle is 16¼ inches. The vertical feed of the spindle is 16 inches, and the vertical motion of the spindle head 27 inches. The diameter of the spindle is 2 1/16 inches.

GEAR TESTING MACHINE

The accompanying illustration shows a gear testing machine built by the Cincinnati-Bickford Tool Co., Cincinnati, O. This machine was originally designed for the company's own use without any intention of placing it on the market; but as many of the company's customers intimated that such



Gear Testing Machine built by the Cincinnati-Bickford Tool Co.

a machine would undoubtedly meet with favor if made on a commercial basis, it has finally been decided to manufacture it for the trade. The machine is intended for testing the running of both spur and bevel gears. The gears are mounted on the removable studs shown, which are held in adjustable slides, moving freely. Provision is made for clamping these slides at any point. Each slide is capable of a fine adjustment by means of a screw and knurled nuts, the screws being seen in the illustration, one running horizontally and one vertically on the side of the machine. A vernier scale is also provided, reading to thousandths of an inch, so that

the correct center distances between the gears when mounted on the studs can be determined. The shortest distance from center to center of the two studs for testing spur gears is 2 inches and the greatest is 19½ inches. This permits of testing a pair of gears where the sum of the pitch diameters of the gears is 4 inches as a minimum and 39 inches as a maximum. The two studs for bevel gears permit of testing miter gears from the smallest made up to 18 inches in diameter, and of a combination of bevel gears where one is 4 inches and one 32 inches in pitch diameter. Each machine is furnished with two studs one inch in diameter, and 4 inches long above the slide. Extra studs can be furnished if required.

The slightest imperfections in the gear teeth are readily detected by this testing device and the cause can be analyzed with comparative ease. By remedying the defects, it is possible to produce gears that have a perfect bearing on the surfaces in contact, and that will run smoothly and noiselessly when in service. The net weight of the machine is 325 pounds and the floor space required, 16 by 34 inches.

QUEEN CITY DOUBLE-ACTING PRESS

A new double-acting press has recently been placed on the market by the Queen City Punch & Shear Co., 208 Lawrence St., Cincinnati, O. The machine has been designed for forming and pressing operations of various kinds in sheet metal, and is of especial value where a large quantity of duplicate work is to be done. The main feature of the machine is the oscillating table, presenting a feature whereby the operator is safeguarded from personal injury. Patents have been applied for, for such features as are new departures in this design. The general construction and operation of the machine will be more easily understood by referring to the accompanying two half-tone engravings, Figs. 1 and 2, one of which shows the front view and the other the rear view of the machine.

Two operators are required for the machine, to feed and remove the work, one standing in front of the machine and the other in the rear. In the illustration, Fig. 1, the plunger or ram is shown down and the front die projects out in the front of the machine. This is the proper position of the die when the work is removed, and the die remains in this position sufficiently long without motion so that the operator in the front can remove the finished work and replace it with a blank, meanwhile being entirely out of the range of the plunger and without any danger of injury. The plunger then raises up and the die moves in under the ram for pressing or forming the blank just inserted. While this is being done the rear die projects outward in front of the operator in the rear, see Fig. 2, who then removes the finished work from this die and replaces it with a blank. It is evident that there is no occasion for the operators to place their hands or fingers under the press plunger, and the danger thereby avoided is of equal importance to employe and employer, for while the former, of course, is the one who suffers most directly through the bodily injury in case of accident, it is also a very important feature to the manufacturer, who is continually liable for damages sustained to operators when working with machines where the operation presents a constant danger to the workman.

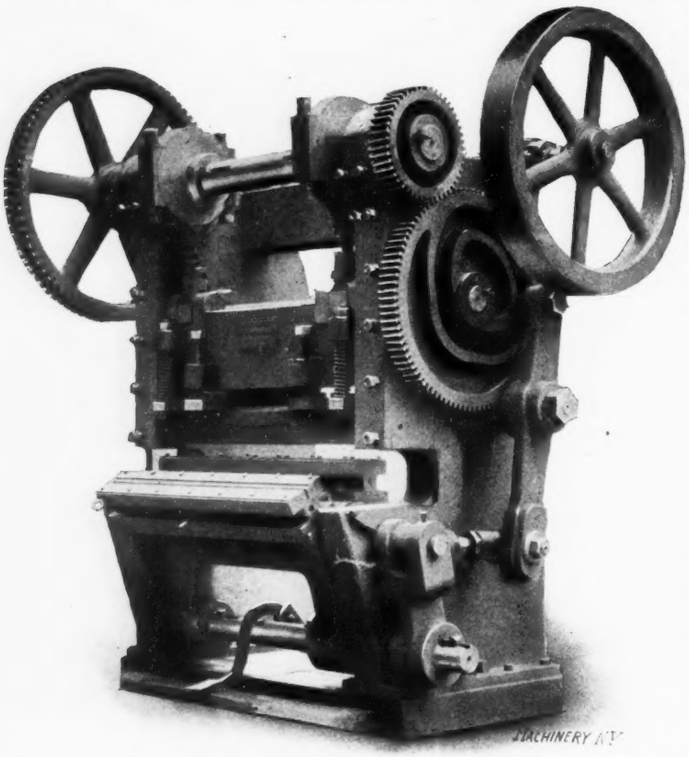


Fig. 1. Front View of the Queen City Double-acting Press

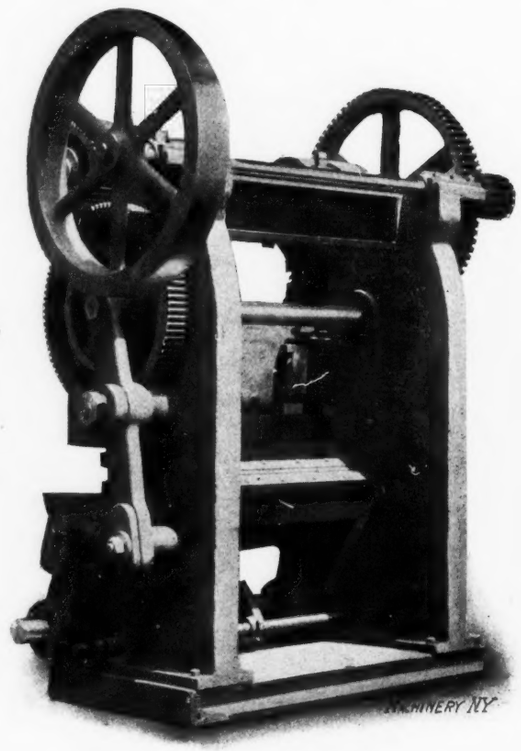


Fig. 2. Rear View of Double-acting Press

The machine runs continually, the movements being divided in two equal periods of time, as follows: One-half of the revolution of the cam-shaft is devoted to pressing the work in the die, removing it when finished and replacing it with a new blank; the other half of the stroke allows the filled die to enter the pressing ram; this is repeated for each of the two tables or dies, thereby making it possible to press a piece of work for every revolution of the cam shaft. There is no necessity of stopping the machine except in a case of emergency, but the machine is provided with an automatic safety clutch by which either of the operators can stop the machine at will. The speed of the machine can be regulated and is governed by the character of the work to be done and by the rapidity with which the operators can handle the finished work and the blanks.

The machines of this type are equipped with machine-cut gears and can be either belt or motor driven, as required. The machine illustrated in Figs. 1 and 2 is 36 inches between the housings and weighs 7,300 pounds. It can be built in any size required and adapted to any class of forming or pressing. The novel features introduced in the design of this machine should make it a valuable tool in the sheet metal trades, both on account of its productive capacity and the safety of operation.

COLBURN 30-INCH VERTICAL BORING MILL

A new 30-inch vertical boring mill embodying a number of interesting improvements has recently been brought out by the Colburn Machine Tool Co. of Franklin, Pa. The most prominent feature of the new design is embodied in the main drive or head-stock, which is enclosed in a separate box or frame, and which can be quickly detached from the main frame of the machine and removed if required. This construction makes the assembling of the machine very convenient, and enables the proper fitting of the various parts to be done with greater accuracy. This feature is also of advantage in case of repairs, as all the parts are easily accessible and can be handled without difficulty. Another feature of special interest in the machine is the addition of a foot brake for quickly stopping the machine with the table in any desired position; this feature is not generally found on small boring mills. A general view of the machine is shown in Fig. 1, and in Fig. 2 is shown a view of the head-stock detached from the machine. In Figs. 3 and 4 are shown sectional views which give a clear idea of the construction of the machine.

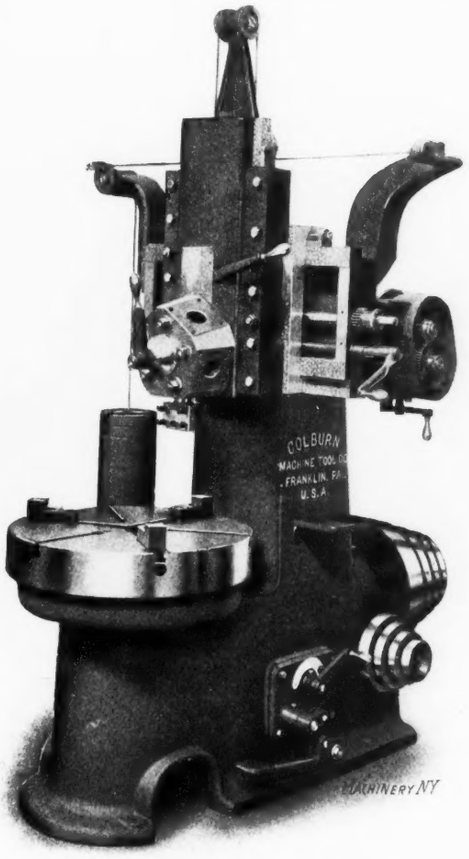


Fig. 1. Thirty-inch Vertical Boring Mill, built by the Colburn Machine Tool Co.

As will be seen from Fig. 1, the turret is five-sided. It is set on an angle of 8 degrees with a vertical line which gives sufficient clearance for large tools when swung over the slide. The turret slide can be swiveled to any angle up to 30 degrees to either side of the vertical center line. A graduated scale with a pointer is provided which makes it convenient to measure the depth of the cut taken. The boring mill is provided with a plain table having three or four chuck jaws, as required. The main spindle has sixteen speed changes, and provision is made for eight feeds vertically, and the same number horizontally. The machine is furnished with a two-speed counter-shaft.

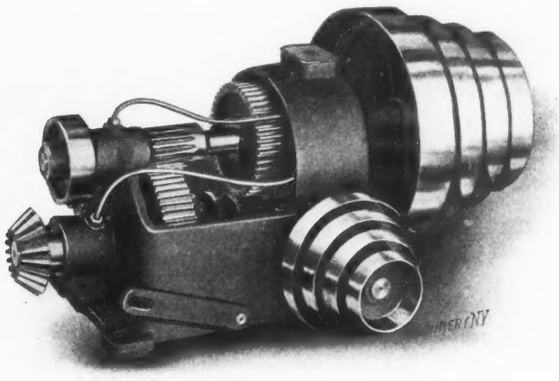


Fig. 2. Driving Head of Colburn Boring Mill

Construction of Driving Mechanism

In Fig. 3 is shown a cross-section of the head of the machine, the table, the lower part of the frame and the driving mechanism. The motion from the cone pulley *E* to the table is transmitted through shaft *F* to which are keyed a gear *G* and a pinion *H*, which in turn drive the gears *K* and *L*. These latter two gears revolve loosely on the shaft *M*. A clutch operated by the handle on the outside of the frame directly above the foot treadle, as shown in Fig. 1, is provided with teeth on the face on both ends, and can engage with the clutch teeth on the sides of either gear *K* or *L*. By this arrangement two speeds are provided for, and by means of the four-step cone pulley eight speeds are obtained. The two-speed counter-shaft increases this to sixteen speeds.

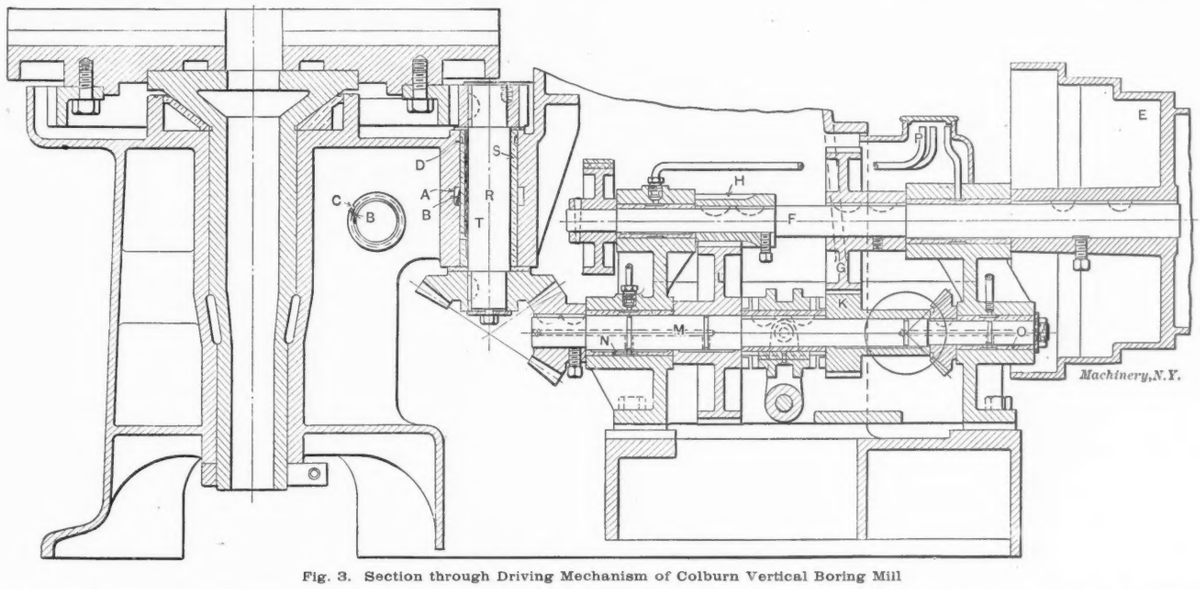


Fig. 3. Section through Driving Mechanism of Colburn Vertical Boring Mill

From shaft *M* the motion is transmitted in the usual manner by bevel and spur gearing to the table.

Method of Lubrication

Special attention should be called to the manner in which all running bearings are lubricated. The two gears *K* and *L* which run freely on shaft *M* are oiled through holes drilled through the center of the shaft *M*, as shown, the oil being carried to the gears from the bearings *N* and *O*. Brass tubes which all end at the common location *P*, under a cover provided at the top of the gear guard enclosing the head-stock gears, lead to every bearing in the head-stock. These tubes are indicated in Fig. 3 and some of them are visible in the half-tone illustration of the head-stock Fig. 2. This arrangement greatly facilitates the lubrication of the bearings, since it is only necessary to lift the cover of the guard and pour oil into all the different tubes, which here converge to one point.

The manner of oiling the bearing for the vertical shaft *R* is also of particular interest. This shaft runs in a large bushing *S*. An oil pocket *A* surrounds the bushing about midway of its length. This pocket is filled with oil and a wick *B* starts from the pocket *A* and leads upward through a slot *C* on the outside of the bushing over the top of the bushing and down through a slot *T* on the side of same. This method insures practically perfect lubrication, since the oil is only fed through the wick in the required quantities and in an amount determined by the amount used, on the same principle as that of an oil lamp. As long as there is any oil left in the reservoir, the wick will feed it to the bearing. Should the supply in the reservoir run out, there will always be a sufficient amount in the wick to insure the bearing running reasonably well lubricated for a long time without causing any difficulties. Oil is supplied to the reservoir *A* from the outside by means of the pipe shown directly in front of the tool-pan in Fig. 1. This pipe leads to annular groove *D* cut in the bushing *S*, whence it flows downward to the reservoir *A*. Thus, in fact, two supplies of oil are maintained, one at *D* and one at *A*, making it practically impossible for the bearing to ever become dry.

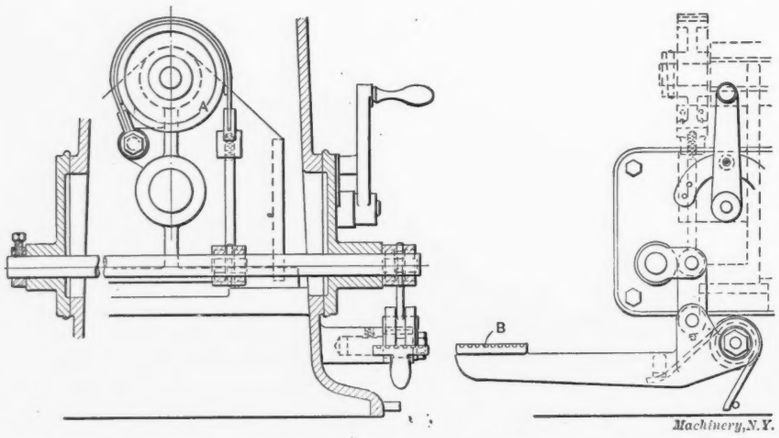


Fig. 4. Foot Brake Mechanism for Stopping the Table at any Point

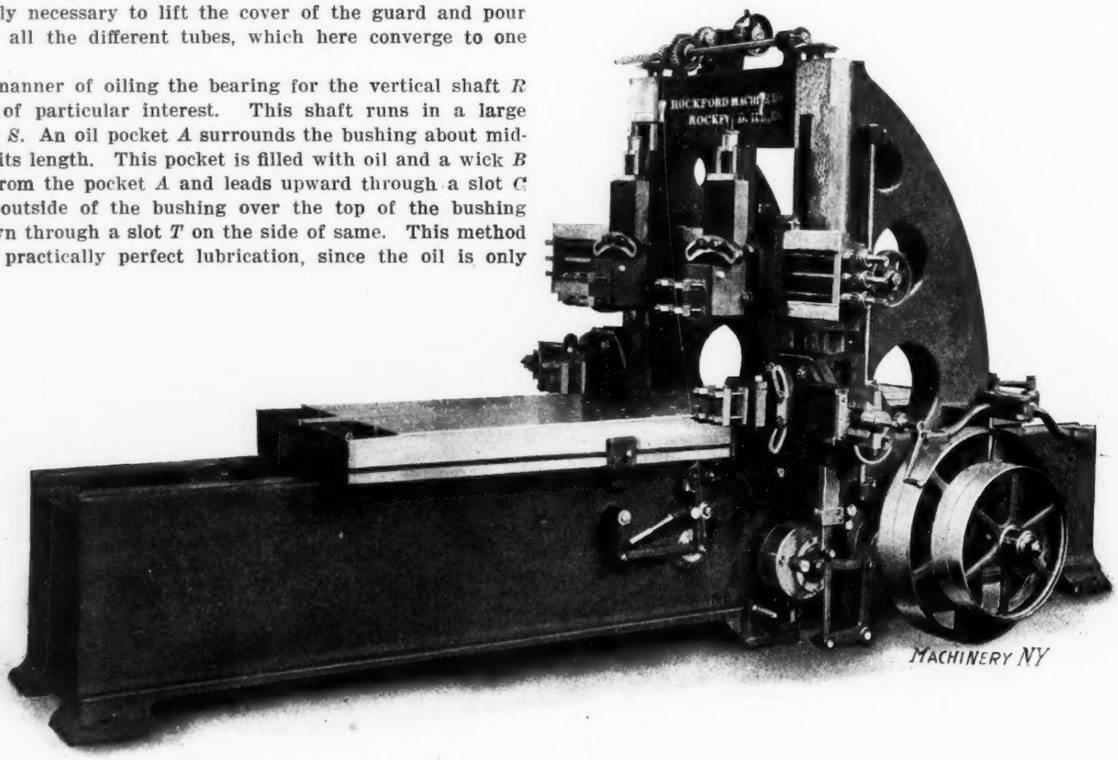
Brake Mechanism

The line engraving Fig. 4 shows the brake mechanism. The band-wheel *A*, which is also shown in Fig. 2 directly above the bevel gear at the left-hand end of the head-stock, is used in connection with the foot brake *B* for stopping the machine at any desired point. The details of the mechanism are simple in their construction, and the working of the brake can be studied without difficulty from the illustration. The leverages of the foot treadle arm are of such a ratio that considerable power is exerted at the band-wheel by even a comparatively light pressure on the treadle at *B*.

The new features embodied in this boring mill make it a very convenient tool, and its distinctive points will undoubtedly be appreciated by mechanics.

ROCKFORD HEAVY DUTY PLANER

The accompanying illustration shows a planer manufactured by the Rockford Machine Tool Co., of Rockford, Ill., and is known as the 32-inch by 32-inch by 8-foot heavy duty planer. This company has been for some time manufacturing planers in smaller sizes, in addition to its line of shapers, and have recently developed a full line of planers, the feature of the design of which is, in the first place, rigidity and power, while at the same time efforts have been made to maintain the smooth running qualities and the ease of operation required of modern machine tools.



Rockford 32-inch x 32-inch x 8-foot Heavy Duty Planer

As seen in the illustration, the planer is equipped with four heads of which two are placed on the cross-rail and one on each side of the machine on the housing. All the heads are provided with horizontal, vertical and angular feeds. The down feed for the heads on the cross-rail is 12 inches.

The gearing of the main drive is located inside of the planer bed between the bearings. These latter are provided with long straight bushings fitted into holes bored directly into the bed casting. The belt shifting device is of a very simple construction and reverses the table smoothly. Ample means are provided for lubrication.

The feed friction is of the combination releasing type and will carry the heaviest feeds without slipping or running warm. The feeds are changed by moving the knob shown in the illustration on the front of the friction device, a pointer indicating the feed obtained at different settings of the lever.

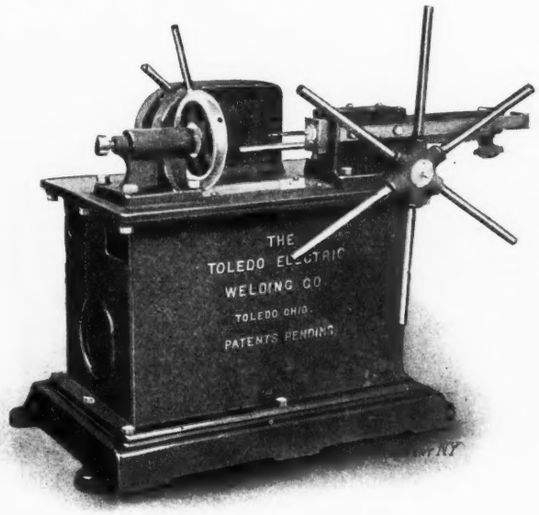


Fig. 1. Machine for Electrically Welding Small Drills to their Shanks

By means of this device the feed can be changed for the finishing cut after having rough planed a piece of work, and the lever can be instantly returned to the position for the roughing feed for the next casting. Besides the time thus gained, an additional advantage is obtained in that the operator knows exactly what feed he is using, and can get the feed he wants without making several adjustments.

All running bearings are provided with means for adjustment for wear and taper gibs are used in the slides throughout the machine so that any wear may easily be taken up in these parts. Bevel gears, pinions and feed racks are made from open-hearth bar steel. The machines are built on the interchangeable plan, and side heads can be furnished at any time to fit the machines, if not originally so equipped.

TOLEDO ELECTRIC WELDING MACHINES

The Toledo Electric Welding Co., Toledo, O., has brought out a line of electric welding machines for various purposes, three of which are shown in the accompanying illustrations. The machine shown in Fig. 1 is intended for welding small drills to their shanks, one of the drills being shown in place in the machine. The head on the left-hand end is provided with a chuck for holding the drill. Sockets are provided for different sizes of drills, and the varying lengths are taken care of by means of the adjusting bolt with a knurled head, shown at the left-hand end of the head. By this arrangement every drill projects the same distance from the clamping jaws. The shanks of the drills are held in the chuck shown at the right-hand end of the machine. The two heads are brought together by turning the spider on the right-hand head; the pieces, when brought together, are in practically perfect alignment.

The automatic switch shown at the back of the machine is adjustable and can be set to open the circuit at any predetermined point. This enables the operator to set the machine so as to make the welds with a great degree of accuracy. After the weld is made, the drill is automatically thrown out, and the chucking jaws are in a position ready to receive another drill. The operation of this machine is simple and no expert operator is required.

Fig. 2 shows a larger machine designed for welding tubing, such as automobile steering rods, etc., or solid bars up to and including 1⅛-inch round iron or steel. The stock is clamped between the copper jaws by means of the handwheels shown at the top of the machine. The right-hand head slides back and forth in ways on top of the machine bed, and is actuated by the spider shown at the right-hand end of the machine. The current is turned off and on by means of a foot switch shown on the floor at the side of the machine.

The clamping dies project far enough above the top of the table to permit bars or tubes of any length to be conveniently handled and welded without in any way interfering with

Fig. 2. Machine for Welding Tubing and Solid Stock of Large Sizes

the working mechanism. The line of thrust is in the center of the work-holding jaws, thus insuring alignment of the parts when welded. The copper jaws are water cooled in all of these machines.

Fig. 3 shows a universal welding machine which welds solid iron or steel up to and including ¾-inch diameter. The

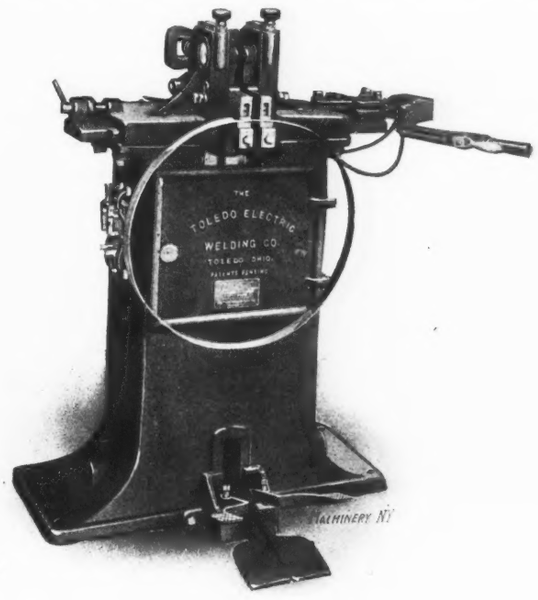


Fig. 3. Universal Welding Machine for Steel up to ¾-inch Diameter

clamping jaws are here actuated by foot treadles, and the current is turned on or off by means of a switch mounted on the lever handle shown at the right-hand end of the machine.

These welding machines are, of course, adapted to work done in quantities and are not intended for the average repair man, who has only a few pieces to weld per day. When work is done in quantities, however, the cost per weld is very small. The accompanying table gives a general idea of the time required for making a weld and the cost per

1,000 welds if the current cost is, say, 4 cents per kilo-watt hour. If the cost of current is more or less than this, the total cost will, of course, be accordingly greater or less. Figs. 4 and 5 show some examples of work which has been electrically welded on the machines shown. These illustrations also give an idea of the variety of work that can be done on these machines. On some pieces part of the metal at the weld has been cut away to the center in order to show the internal structure of the metal at the place where the weld is made.

The underlying principle of the electric welding machine is simple and is based on the fact that a poor conductor of electricity offers so much resistance to the flow of the current that heat is produced, the degree of heat depending on the amount of current and the resistance of the conductor. The process of electric welding is especially applicable to butt welding of metals having practically the same cross-section at the weld. The temperature produced by the current can be maintained at any point desired for any length of time, and any degree of heat may be obtained up to the melting point of the metal. The heat can be increased and decreased at the will of the operator by means of turning on or cutting off the current by the switch on the machine.

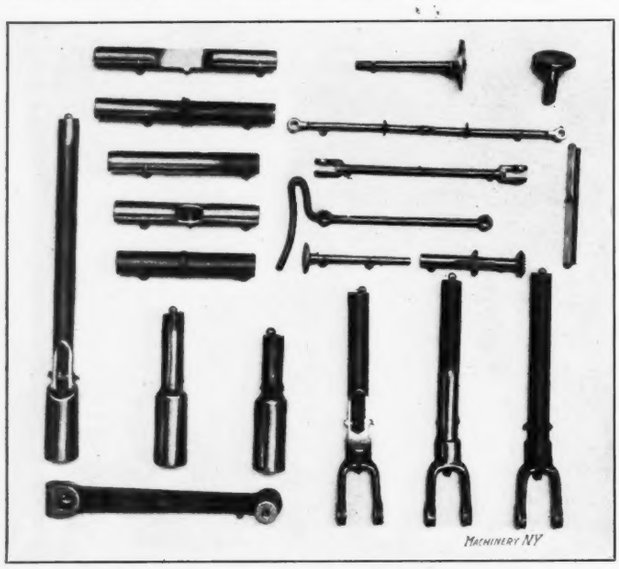


Fig. 4. Examples of Work Welded Electrically

An advantage of the electric welding process is that there is none of the disagreeable glare or blinding effect which takes place either in the arc welding process or the oxy-acetylene process of welding. No goggles or smoked glasses are, therefore, needed. No flux is required in making an ordinary weld.

For electric welding an alternating current is necessary. The current as supplied from a dynamo in the plant or from a central power station is transformed so that it has a pressure of from 4 to 5 volts, there being then absolutely no danger for the operator. The copper clamping jaws of the electric welding machine are similar to a pair of movable

TIME REQUIRED FOR MAKING WELD, AND COST OF 1000 WELDS

Diam. Round Iron or Steel, Inches	Seconds required to Make a Weld	Cost of 1000 Welds at 4 cents per Kw.-hour	Diam. Round Iron or Steel, Inches	Seconds required to Make a Weld	Cost of 1000 Welds at 4 cents per Kw.-hour
¼	3	$0.28	⅝	10	$1.32
5/16	5	0.52	¾	12	2.00
½	7	0.88	1	20	6.00

vise jaws, and form the terminals of the secondary current of a special transformer located in the welding machine.

When two pieces of iron are to be welded they are clamped between the vise jaws, the ends of the metal to be worked touching each other. The current is then turned on and when the metal reaches a white heat and is in a partially molten state, the ends of the metal are forced together by means of a lever, thus producing a perfect weld. A projection or fin is raised where the ends come together, but this may be ground off or removed by any other suitable means. A weld

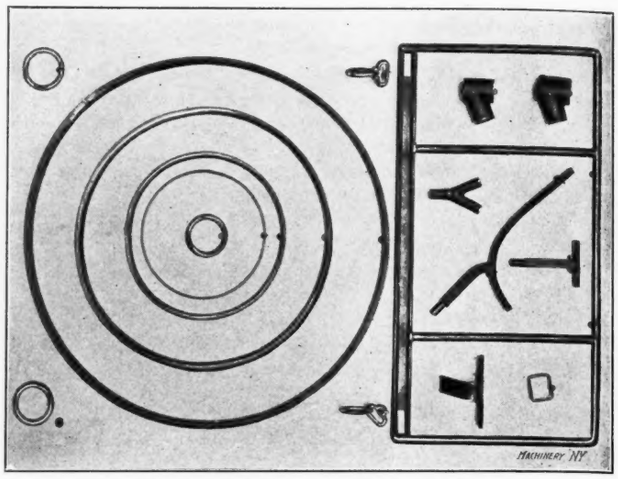


Fig. 5. Other Examples of Electric Welding

properly made in this manner is practically as strong at the welded point as at any other place.

NEW MODEL "STAR" LATHE

The Seneca Falls Mfg. Co., 330 Water St., Seneca Falls, N. Y., has re-designed its line of 9- and 11-inch "Star" lathes. The accompanying illustration, Fig. 2, shows the lathe having 11-inch swing with a 5-foot bed, known as the No. 30H Star lathe. The following description of the improvements in this lathe also applies to the 9-inch size.

The bed of the machine is mounted on an oil pan as shown. In the head, guards have been provided for the back-gears, and the main spindle, which is made of 60 to 65 point carbon steel, revolves in large ring oiling bearings. The spindle nose is threaded only part of the way, and the remainder is ground cylindrical so as to insure accurate fit for chucks and face-plates. The tail-stock has been made heavier to insure greater strength, and has a longer bearing on the bed; it is provided with side adjustment and an oil-well. The carriage has been made stronger and is provided with T-slots for fastening the tool-posts. The cross-feed screw and the ways have

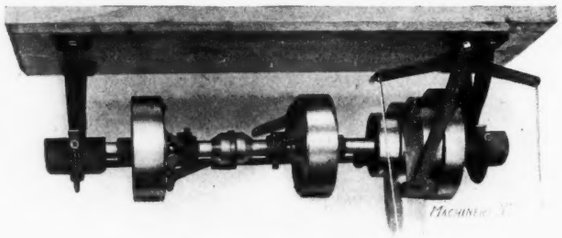


Fig. 1. Counter-shaft for the "Star" Lathe

been carefully protected from chips and dirt by a guard reaching the full length of the slide. The cross-feed screw is provided with a micrometer collar graduated to read in thousandths of an inch, and secured by a friction spring. Even when the machine is not originally provided with a taper attachment, the carriage is so designed that a taper attachment can be applied to the lathe at any time. The plain and compound rest easily interchange, and a binding device has been introduced which facilitates quick changes and rigidly binds the rest to the cross-slide. Graduations up to 180 degrees are provided for setting the compound rest.

The automatic cross and longitudinal feeds are actuated by a friction clutch and driven from the head spindle through gearing and the splined lead-screw, as usual. The range for thread cutting is very wide, it being possible to cut all standard threads from 3 to 72 per inch, including 11½ and 27. The lathe is also furnished for cutting metric threads, either by using proper translating gears with the regular lead-

screw or by using a lead-screw having threads cut with metric pitch.

The change gears have rounded edges so as to avoid injuring the hands when handled. The change gear yoke has an improved intermediate stud which is adjustable from the outer end. All the adjusting screws are provided with uniform size heads, fitting the same wrench as is used for the tool-post screw. Patented split spring washers hold the change gears in place, making convenient and rapid changing of the gears possible.

A full line of regular attachments may be used with this machine including taper attachment, draw-in chucks and collets, automatic draw-in chuck and rod feed, milling and gear cutting attachments, automatic turret on the bed, carriage turret, double tool block, and stop for the carriage. These attachments can be furnished and applied to the machine at any time without special fitting.

Fig. 1 illustrates a new counter-shaft furnished with the machine which is provided with improved friction clutch pulleys with large friction surfaces. In this counter-shaft the wear on the friction parts when the pulley is running idle, has been eliminated, and the usual counter-shaft troubles are, therefore, renduced to a minimum. The belt-shifter for the cone pulley shown in place on the counter-shaft operates quickly and will be found very convenient especially with high ceilings. The hangers are provided with large ring-oiling shaft bearings and are adjustable for alignment. The advantages of these features will undoubtedly be appreciated by the lathe operator.

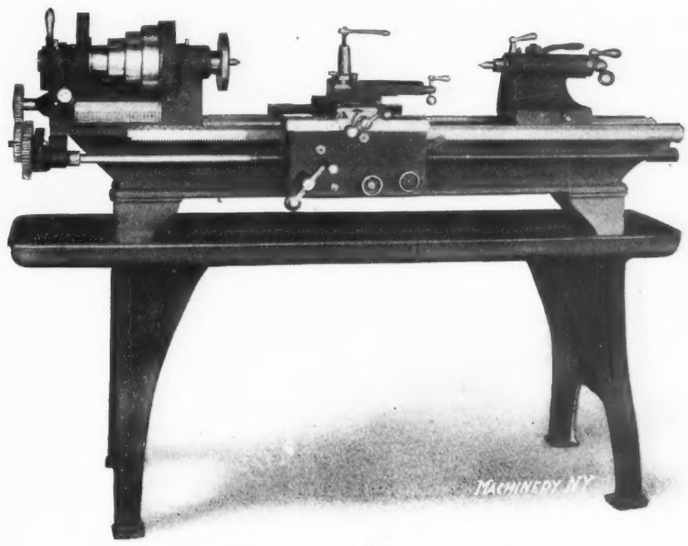
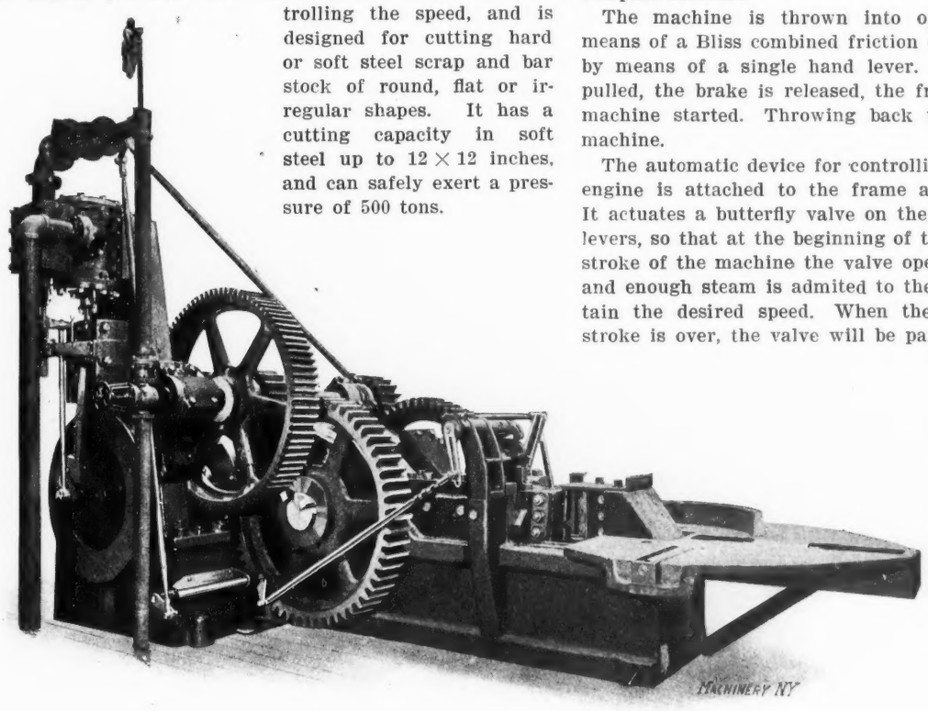


Fig. 2. New Model 11-inch "Star" Lathe, built by the Seneca Falls Mfg. Co., Seneca Falls, N. Y.

BLISS HORIZONTAL SHEARING MACHINE

The accompanying illustration shows a special horizontal shearing machine built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. The machine is driven by an independent steam engine, provided with an automatic device for controlling the speed, and is designed for cutting hard or soft steel scrap and bar stock of round, flat or irregular shapes. It has a cutting capacity in soft steel up to 12×12 inches, and can safely exert a pressure of 500 tons.



Bliss Heavy Horizontal Shearing Machine

The slide carrying the cutting knife is designed rather long for the purpose of providing proper guidance. The socket and pin for the pitman end are near the middle of the slide; in this way the downward pressure of the pitman is utilized for minimizing any lifting tendency due to the shear of the knives. The slide is held in position and guided by beveled gibs, firmly bolted both horizontally and vertically. These gibs are designed with a view of making provision for taking up the wear. The stroke of the slide is 4½ inches, which allows the moving knife to safely clear the bar or piece when it is fed in to be cut. The pitman is of cast iron, and the frame, slide and gearing are steel castings. The crank-shaft is made of 50-point carbon open-hearth steel and is 10 inches in diameter in the bearings; the eccentric portion, which serves as a crank, is 14½ inches in diameter. The shaft is driven from both ends, there being a main driving gear on each side of the press. This arrangement tends to reduce the stresses, and makes possible a more rigid and compact machine.

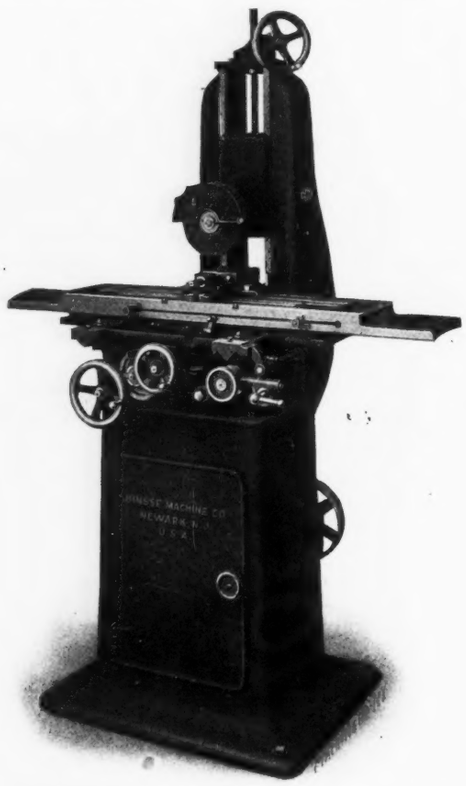
The machine is thrown into operation and stopped by means of a Bliss combined friction clutch and brake operated by means of a single hand lever. When the hand lever is pulled, the brake is released, the friction thrown in, and the machine started. Throwing back the hand lever stops the machine.

The automatic device for controlling the speed of the steam engine is attached to the frame and slide of the machine. It actuates a butterfly valve on the engine through rods and levers, so that at the beginning of the working portion of the stroke of the machine the valve opens wider than previously, and enough steam is admited to the engine cylinder to maintain the desired speed. When the working portion of the stroke is over, the valve will be partly closed, thereby reducing the amount of steam admitted to the engine, and thus preventing excessive speed. This device takes the place of the usual engine governor.

The cylinder of the steam engine is 12 inches in diameter and the stroke is 14 inches, the speed of the engine being from 200 to 250 revolutions per minute. All the gearing is machine cut, and it has a ratio of 17 to 1, which gives a speed of from 12 to 15 strokes per minute to the slide of the machine. With a steam pressure of 80 pounds, the engine will deliver from 70 to 90 H. P. at the speeds mentioned above. The total weight of the machine, including the engine, is approximately 65,000 pounds.

BINSSE SURFACE GRINDING MACHINE

An improved design of surface grinding machine, as shown in the accompanying illustration, has been brought out by the Binsse Machine Co., Newark, N. J. The most important improvements of the design are the added rigidity and the provisions for taking up wear and preserving the alignment—



Surface Grinding Machine built by the Binsse Machine Co., Newark, N. J.

the most important points in securing long life in grinding machinery. The working parts and the feed mechanism have also been efficiently protected from dirt and chips by ample covers and guards, and the arrangement of hand-wheels and levers has been taken care of in such a manner that the greatest possible ease in the manipulation of the machine is assured.

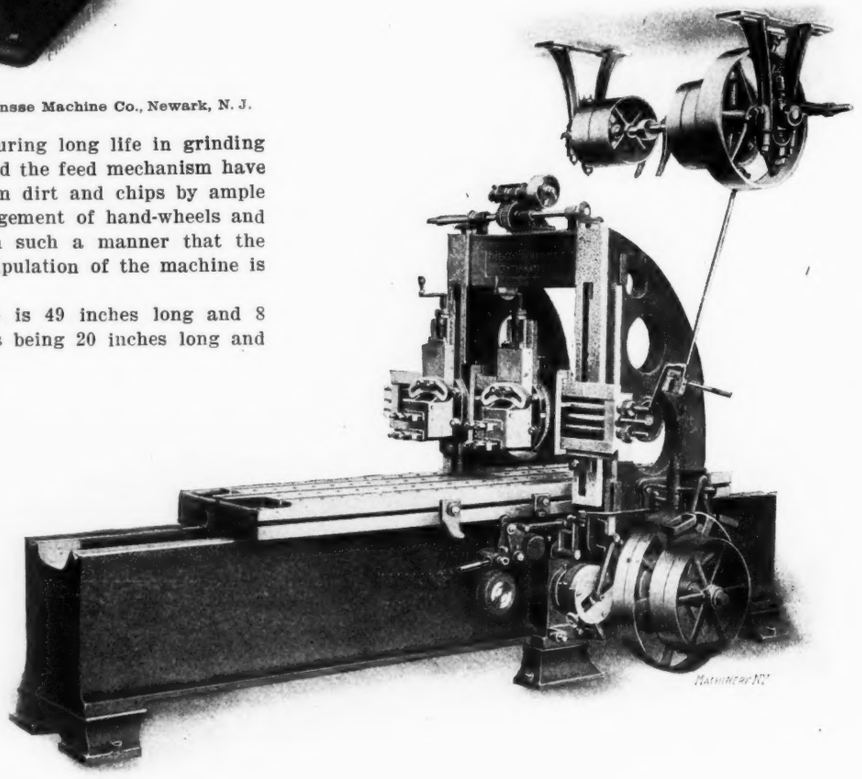
The work-table of the machine is 49 inches long and 8 inches wide, the working surfaces being 20 inches long and 6 inches wide with three slots ½ inch in width. The largest piece of work which can be ground on the machine, using a 7-inch diameter wheel, is 20 inches long, 6 inches wide and 10 inches high. The table is provided with automatic motion in the longitudinal direction, and an automatic cross feed. The length of the stroke is regulated by dogs in the usual manner. The reversing lever can be turned down so it will clear the dogs, thus enabling the table to run past the reversing position, if required, without changing the adjustment. A hand-operated movement for the table is also provided which enables the operator to move the table by hand without changing the automatic feed. The automatic cross-feed movement of the table may be worked in either direction, and it can be stopped automatically when the cut has passed over the work.

The spindle is made of tool steel and is hardened, ground and lapped, and runs in bronze boxes provided with adjustment for taking up all lost motion. The end of the spindle is tapered to receive the wheel flanges. The vertical movement of the spindle is controlled by a hand-wheel at the top of the machine, as shown, which is provided with a graduated dial reading to one-half thousandths of an inch. The shortest distance from the spindle center to the table is 3½ inches and the maximum distance 13½ inches. The maximum size wheel that can be used is 7-inch diameter by ½-inch face.

The machine is equipped with a 7-inch emery wheel, ½-inch face, 1¼-inch hole, with one pair of wheel flanges; a complete separate counter-shaft with tight and loose pulleys, 8 inches in diameter for a 3-inch belt; wrenches and spanners; and flanged vise with hardened jaws, 4⅛ inches long, 1 1/16 inch deep, opening to 2 inches. The counter-shaft should run at a speed of 360 revolutions per minute. The net weight of the machine is 1,500 pounds, and the floor space 6 feet by 3 feet.

CINCINNATI TWO-SPEED PLANER DRIVE

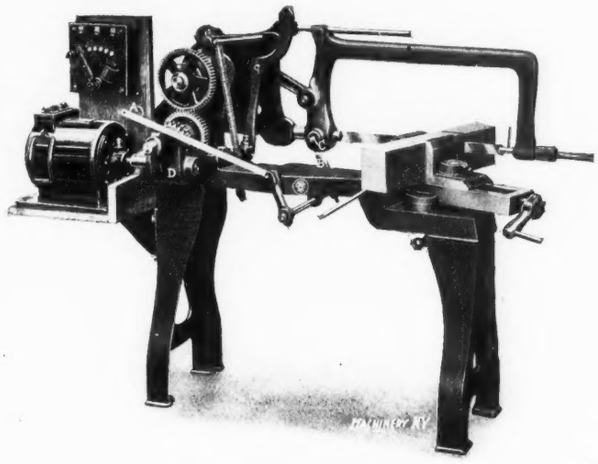
The accompanying illustration shows a planer provided with a two-speed drive brought out by the Cincinnati Planer Co., Cincinnati, O. By means of this drive two cutting speeds for the table are obtainable with a constant return speed. Either of the two cutting speeds can be obtained instantly, and change from the one speed to the other can be made while the machine is running. The speed change is accomplished by the arrangement of the pulleys in the counter-shaft, the drive consisting of two sets of pulleys, one pulley in each set being keyed to the shaft and the other pulley running loose. By operating the lever shown at the side of the housing, either speed required is obtained, the high speed by moving the belt to the right and the low speed by moving the belt to the left. The return belt remains in one position, giving a constant return speed to the table, as mentioned. The simplicity of construction and ease with which the device can be manipulated, makes it very useful for the planer drive; and it can be applied advantageously to all planers from 22 inches to 36 inches, inclusive.



Cincinnati Planer Co.'s Two-speed Planer Drive with Constant Return Speed

ROBERTSON MOTOR-DRIVEN HACK-SAW

The accompanying illustration shows a motor-driven hack-saw built by the Robertson Drill & Tool Co., Department 5, Buffalo, N. Y. The machine shown is known as the No. 3 saw, but all the sizes of the company's saws may be motor-driven by using the same attachment as applied to the present machine. The motor is mounted on a bracket secured to the rear leg of the frame of the machine and provision is made on the same bracket for mounting the rheostat or starting box. The machine is provided with an automatic stop arrangement working through the levers *A* and *B* and actuated by the pin *C*. Lever *A*, shown disconnected in the engraving, connects the switch handle with the cutting mechanism, and when the cut is completed, pin *C* will trip lever *B*, thereby throwing the switch and stopping the machine by cutting off the current.



Robertson Motor-driven Hack-saw

The machine is driven from the motor through a worm and worm-gear, the worm being placed on the motor shaft inside of the housing *D* and the worm-gear on a shaft on which a spur gear is also mounted from which in turn the power is delivered to the reciprocating saw mechanism. The worm and worm-wheel run in oil.

The machine can be conveniently mounted on a platform or truck and taken to any place inside or outside of the shops, where beams, bars or other steel parts have to be cut. It thus serves the purpose of a portable machine, and the only thing necessary is that electric power be available, so that the machine can be easily connected by wiring at any place where it is to be used.

STARRETT'S MACHINISTS' AND TOOL-MAKERS' TOOLS

A number of new machinists' and tool-makers' tools have been recently brought out by the L. S. Starrett Co., Athol, Mass. Fig. 1 shows a taper gage in which the thin leaves

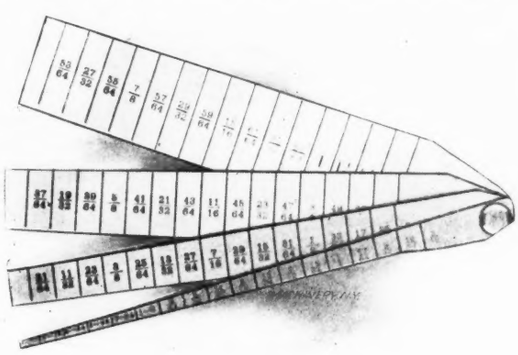


Fig. 1. Starrett Taper Gage

are tapering, the widths varying by 1/64 inch for every quarter inch of the length of the gages. The gages are graduated by lines ¼ inch apart, and on each gage is stamped the width at each division, the graduations reading by 64ths from 1/16 up to 1 1/16. The gage is designed for brass and steel tube manufacturers, for inside measurements, and is also convenient for tool-makers and machinists when measuring the width of slots and the size of holes, as well as for setting calipers to size within its capacity.

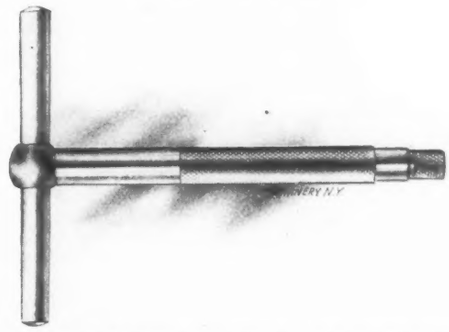


Fig. 2. Telescoping Gage used in conjunction with Outside Micrometer for Inside Measurements

Fig. 2 shows a telescoping inside gage by means of which the exact size of holes or slots can be measured by outside micrometers, so that various classes of fits, varying in thousandths of an inch or less, can be made and measured without resorting to inside micrometers. The instrument is used in the following manner: The telescoping head is compressed and the plunger locked by a slight turn of the knurled screw in the end of the handle. The head is then inserted inside of the hole to be measured, the lock is released, and the plunger allowed to expand to fit the hole. Then the plunger is again locked by a slight turn of the screw. The instrument is withdrawn and is calipered over the ends of the head with a micrometer, thus obtaining the exact size of the hole. The ends of the telescoping head are hardened and are made to a radius equal to that of the smallest hole the instrument will enter. The gages are made in five sizes, the total range of the complete set being made to enter holes from ½ inch to 6 inches.

In Fig. 3 are shown a number of tool-makers' buttons with screws and washers for jig work. The buttons are hardened

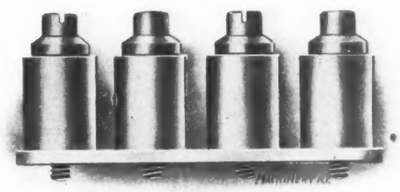


Fig. 3. Tool-makers' Buttons with Screw and Washers for Jig Work

and ground to exact standard size, the diameter being 0.400 and the length ½ inch. The use of these buttons in jig making is well-known to tool-makers, and constitutes one of the most accurate methods for laying out holes with accurate center distances in jigs. These buttons are furnished in sets of four screwed into a small plate, which makes a convenient holder for them when not in use.

MAYMONT SELF-OILING LOOSE PULLEY

The accompanying half-tone illustrations, Figs. 1 and 2, and the line engraving Fig. 3, show a new design of loose pulley brought out by the McMaster-Carr Supply Co., 176 Lake St., Chicago, Ill., and known as the Maymont self-oiling loose pulley.

As shown by the illustrations, the pulley is made in halves and bolted together, and provided with an oiling collar between the two halves. Fig. 1 shows the outside of the enlarged hub which encloses an oil reservoir. This reservoir is plainly shown in Fig. 2, where the two halves of the pulley are shown before final assembling. The two halves are bolted together with a thin oil-proof gasket between, to prevent leakage of oil. The oil distributing collar is fixed to the shaft by two set-screws, and therefore also serves the purpose of shaft collar, so that no outside collar is needed

Fig. 3 shows the construction of the pulley. *A* is the collar with its two set-screws. All the rest of the pulley is free to rotate on the shaft. The collar has two curved wings or lips *B*, extending outward so that they nearly touch the inside walls of the oil reservoir. Close inside of these wings

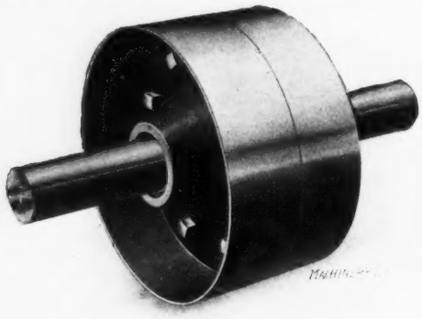


Fig. 1. The Maymont Self-oiling Loose Pulley

are inclined drilled holes *C* passing through the body of the collar and leading to the shaft at each side. Cored into the hubs at the outer ends are recesses *D* and *E*, the former closed and the latter open, as shown. These recesses are connected with the central reservoir by four drilled channels *F*.

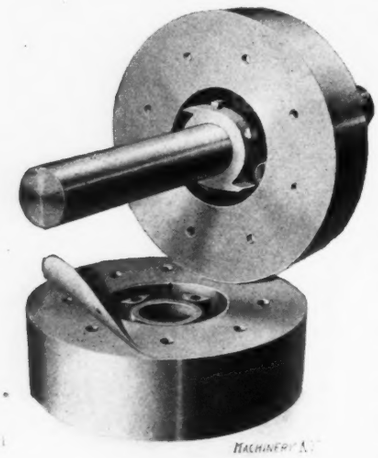


Fig. 2. View of Pulley in Halves, showing Oil Reservoir and Collar

As the pulley rotates, these holes at their reservoir ends pass close to the wings of the fixed collar.

The operation of this device is as follows: As the pulley rotates, the oil in the reservoir is carried up by the wings *B* of the collar, and forced into the holes *C* leading to the shaft, where the oil passes directly onto the surface between the hub halves and the shaft. Working along either way of the shaft, the oil reaches the end recesses *D* and *E*, where the centrifugal force carries it outward to the ports *F* and through them back into the reservoir. As the oil returns through the channels *F*, the wings *B* collect it and again force it into the holes *C*; thus continuous circulation of oil is automatically maintained.

The joint between the two halves of the pulley is made tight by a thin oil-proof gasket as shown in Fig. 2. The centrifugal force prevents oil from leaking out along the shaft when the pulley is in motion, and when it stops the

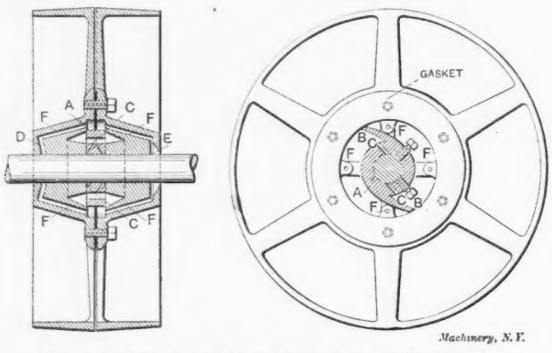


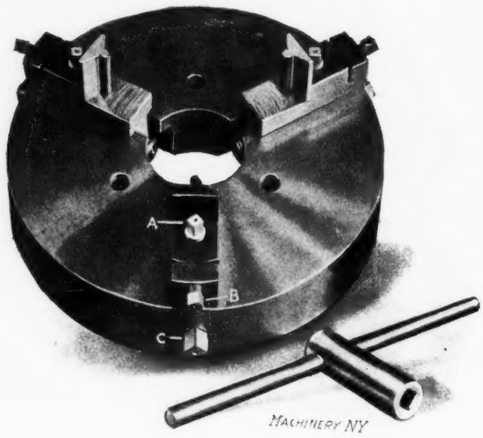
Fig. 3. Section of Self-oiling Pulley, showing Construction

oil in the channels *F* above the shaft will drain to the recesses *D* and *E*, and from there down around the shaft to the bottom of the reservoir. The oil is fed in with the pulley in motion by feeding it in at the open end *E* of the pulley. As there is practically no loss of oil, an addition of a small amount of oil once a month usually maintains the supply.

With slight alterations the construction can be changed to suit vertical and inclined shafts. The pulley is made regularly in sizes from 6 to 30 inches diameter, and with width of face to suit conditions. Special sizes of pulleys are made to order.

SKINNER CHUCK FOR HOLDING AUTOMOBILE GEARS

The accompanying illustration shows one size of a line of special three-jaw universal chucks designed especially for holding automobile gears on the pitch line, and made by the Skinner Chuck Co., 94 No. Stanley St., New Britain, Conn. This line of chucks is especially adapted for use on grinding machines when grinding the holes of hardened gears true with their pitch circle. The chuck shown in the illustration is known as the 12-inch size and is set for a 6-pitch gear with a number of teeth which can be evenly divided by 3. Within



Skinner 12-inch Chuck for Holding Gears true with the Pitch Circle

its range it will hold the gear true at the pitch line at three points. When the number of teeth in the gears is not evenly divisible by 3, it is necessary to loosen the binding screws *A* on two jaws, leaving the third jaw stationary. The gear is then placed in the chuck, and the jaws are adjusted by means of the pinion screws *C*, each jaw being thus permitted to find its own place. The binding screws are then tightened enough to hold the top of the jaws in this position. The gear is removed and each jaw is set an equal distance from the center by means of the independent adjusting screws *B*, a test indicator being used for this purpose. Then the binding screws are firmly tightened and the chuck is ready for operation. Gears of any pitch can be held in these chucks by using interchangeable top jaws with rounded ends of suitable size for the required pitch.

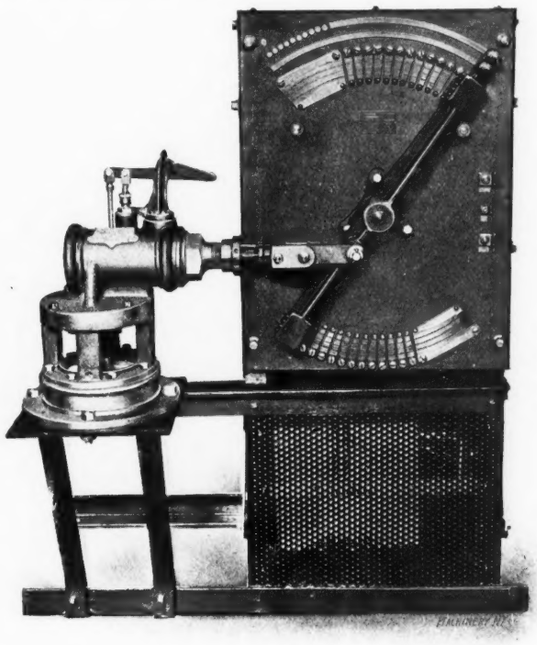
CUTLER-HAMMER PRESSURE-CONTROLLED SPEED REGULATOR

The accompanying illustration shows an interesting speed regulator built by the Cutler-Hammer Mfg. Co., Milwaukee, Wis., and intended for use in connection with electric motors operating the blower of a mechanical stoker, a boiler feed pump, a gas pressure blower, etc. It automatically regulates the speed of the motor to maintain the operating pressure practically constant.

The controlling equipment for use in connection with a direct current motor consists of a standard hand-operated starting rheostat (provided with no-voltage release) and a special speed regulator designed to vary the speed of the motor in accordance with the variations of pressure of the boiler system served by the stoker. The speed regulating part of the equipment may be designed to reduce the speed of the motor below its normal rated speed by inserting resistance in the armature circuit, or to raise the motor speed above normal by field weakening, or by a combination of these two methods.

A direct current blower regulator designed for armature and shunt field regulation is shown in the accompanying en-

graving. Another regulator is also designed for armature regulation only. The regulator consists of a slate panel mounted on the front of an angle iron cage, the panel carrying the contact segments over which a double-ended lever moves. The cage contains the necessary regulating resistance. The lever is actuated by the piston of a hydraulic cylinder, the admission and exhaust port valves of which are in turn controlled by the movement of a pressure regulator diaphragm, one side of which is subjected to the boiler



Cutler-Hammer Pressure-controlled Speed Regulator arranged for Armature and Shunt Field Regulation

pressure. The normal boiler pressure on the under side of the diaphragm is balanced by a weighted lever bearing on the top of the diaphragm in such a manner that the lever will rise or fall as the boiler pressure rises above or falls below the normal pressure for which the lever is counter-balanced. This up and down movement of the lever operates a pilot valve controlling the admission of water to the hydraulic cylinder, and due to the variations in pressure, the piston of the cylinder is moved back and forth, and in turn actuates the double-ended lever, the ends of which move over the contact segments on the slate.

The operation of cutting the resistance in and out of the circuit is not a continuous operation but proceeds step by step with pauses between each movement of the contact lever. This is accomplished by the bell crank connection shown above the cylinder. The lower end of this bell crank is connected to the piston rod of the cylinder and the upper end to the floating lever. Any upward movement of the weight lever results in an upward movement of the floating lever, admitting water to the right-hand end of the cylinder and forcing the piston to move inwardly (to the left), while any downward movement of the weight admits water at the left-hand end of the cylinder and forces the piston rod out (to the right). As soon as the piston begins to move, however, it exerts through the bell crank connection a pressure on the floating lever exactly contrary to the movement produced by the weight lever; that is, if under the influence of increasing steam pressure the weight lever moves up, the pilot valve stem and floating lever will also move up, and the piston rod of the cylinder will start to move to the left. This movement of the piston, however, is presently checked by the operation of the bell crank attached to it which pulls down on the floating lever, depresses the pilot valve stem, and shuts off the water pressure, stopping the movement of the piston and the lever on the slate actuated by it. Thus the lever proceeds step by step with a pause after each movement, resulting in a gradual cutting out of resistance and increase in motor speed.

The cylinder has been assumed to be hydraulically operated in the description above, but if water pressure is not available the same results are accomplished by connecting the inlet of the cylinder to a compressed air tank; the pressure, however, whether air or water, should not be less than 25 pounds per square inch. The system, as described, applies to direct current motors, but a regulator can also be furnished for alternating current motors, the operation being similar to the one described.

MULTIPLE TOOL-HOLDER FOR THE LATHE

A multiple tool-holder which was invented by Mr. F. J. Brewer and placed on the market by the Multiple Tool-Holder Co., 3197 West 48th St., Cleveland, O., is shown in the accompanying illustrations. As shown in Fig. 2, this tool-holder can be used for holding four tools at a time, and it is, in fact, a small temporary turret which can be applied to any engine lathe. Provision is made for indexing the upper part of the holder to different positions, so that the tool is particularly useful when a number of similar pieces are to be made and but few operations are necessary. This holder can also be used with equal advantage for chucking work, boring and turning. It is provided with a T-shaped bottom piece which fits in the slot where the usual tool-post is attached to the cross-slide of the lathe. This bottom piece, *B*, Fig. 1, is held in place by two set-screws *C* so that it will not shift when the top part of the holder is loosened for the purpose of indexing it. Indexing pins *D* for accurately locating the upper or turret part of the holder, are provided. These pins, which operate in threaded bushings screwed into the bottom piece, are pressed against the plate *E* by springs *F*, so that when the turret is turned it is easy to determine when the pins are in alignment with the holes in plate *E*. This plate has eight holes, and it is screwed and doweled to the bottom of the tool-holder proper. All indexing parts are made of hardened

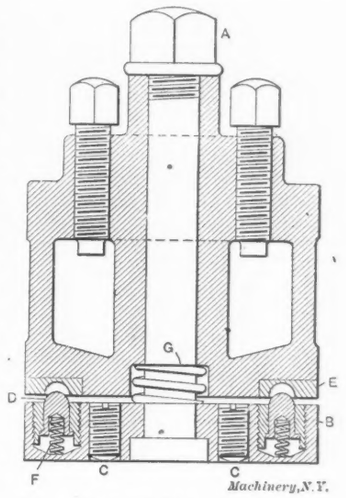


Fig. 1. Sectional View of the Brewer Multiple Tool-holder

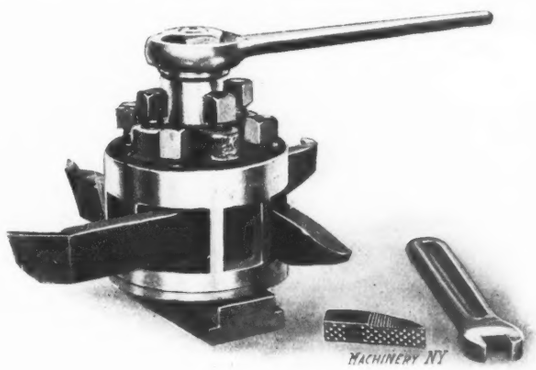


Fig. 2. Brewer Multiple Tool-holder for the Engine Lathe

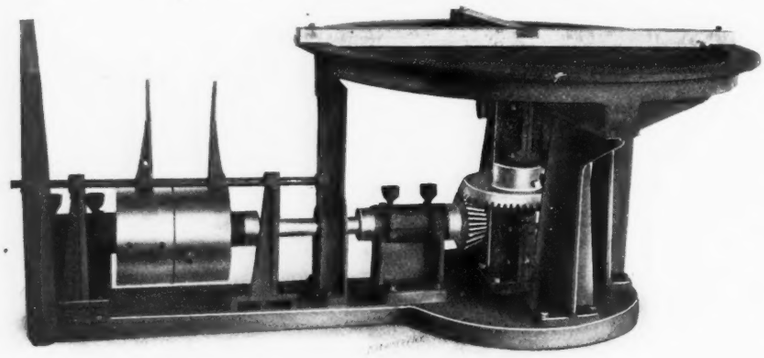
tool steel and the holder proper is a steel casting. The tools are adjusted vertically by the ordinary shoe or wedge, one of which is shown in Fig. 2. Each tool is held in place by two set-screws, and it can be clamped in either of two positions at right angles to each other. When the holder and the tools are properly adjusted, it is securely locked in position by turning the center clamping nut *A*. One-half a revolution of this nut releases the holder so that it may be indexed. When this nut is released the turret part of the holder is lifted by

a central spring *G*. As this tool-holder practically transforms an engine lathe temporarily into a turret lathe for work where only a few operations are required, it will undoubtedly prove a useful tool in any machine shop, particularly as it can be very quickly attached and detached, and in no way interferes with the usefulness of the lathe for ordinary straight turning work.

BESLY HORIZONTAL DISK GRINDER

The accompanying illustration shows a new 48-inch horizontal disk grinder brought out by the Charles H. Besly Co., 15 So. Clinton St., Chicago, Ill. This machine is designed for grinding large surfaces such as fire doors, door jams of furnaces, stove doors, and large gear case covers for automobiles.

The method by which the machine is driven is clearly shown in the illustration. The belt used for driving is 8 inches wide and runs on a 12-inch diameter pulley from which the power is transmitted to the grinding wheel spindle by means of a 2-inch horizontal shaft and bevel gearing. The gears have planed teeth, and all gears and pulleys are keyed and held in place by set-screws directly on the keys. The vertical spindle, to which the large bevel gear is attached, is 3 inches in diameter at the bearings and 6 inches in diameter at the wheel collar, and is provided with a pilot 2 inches in diameter for holding and centering the disk wheel. The thrust is taken by two hardened tool steel blocks, one of which is secured to the lower end of the spindle and rotates



Besly No. 19, Forty-eight inch Horizontal Disk Grinder

with it, while the other is secured to the bed plate. Proper attention has been given to the lubrication of this thrust bearing.

The spindle and driving-shaft bearings are 9 inches long and are of the split type, babbitted and reamed. The disk wheel is 48 inches in diameter and provided with ribs radiating from the hub to the outer rim. The thickness at the hub is 2½ inches, between the ribs ¾ inch, and at the rim 1½ inch. A guard ring is provided around the disk wheel, projecting ¾ inch above the face of the wheel. This prevents the work from flying off the disk wheel while being ground. The top surface of the guard ring is machined true with the face of the disk wheel, so that bars, jigs, etc., for holding the work to be ground can be secured to it. The speed of the disk wheel is 400 revolutions per minute, and the bevel gearing being in the ratio of 1 to 2, the driving shaft should run at 800 revolutions per minute. The machine can be driven either direct from the line-shaft or from a counter-shaft as required. The operating space for the machine is 8 by 10 feet, and the height over all 32 inches. The net weight of the machine complete is 2,400 pounds.

MOTOR-DRIVEN SENSITIVE DRILL

In the June, 1908, issue of MACHINERY, a sensitive drill built by the Rockford Machine & Shuttle Co., of Rockford, Ill., was described. An improvement on this machine was illustrated in the department of New Machinery and Tools in the March, 1909, issue of MACHINERY. The improvement related particularly to the drive, the general arrangement of the machine being unchanged. The company has now brought out a motor-driven machine of the same general design as the one described in the previous issues. The driving cone, however, is eliminated, and a bracket is provided instead on the lower part of the column on which is placed the motor and starting box. The bracket for the motor is mounted on a slide which is vertically moved by means of an adjusting screw so that the tension on the driving belt can be varied. This movement permits an adjustment of 3 inches, which is sufficient to take care of the stretch of the belt for a long time without requiring that the belt itself be shortened. In all other details the machine is the same as that which has previously been described in MACHINERY.

* * *

NEW MACHINERY AND TOOLS NOTES

ANGLE BENDER: Estep & Dolan, Sandwich, Ill. This machine has a capacity for bending round or square stock cold, up to 1¼ inch in size, to a right angle, and it can be used for bending flat stock up to 4 by ½ inch.

IMPROVED BALL BEARING UNIVERSAL JOINT: B. Frank Teal, Glenside, Pa. In this device the journal friction on the trunnions has been largely eliminated by using a ball bearing trunnion with automatic lubrication. The bearings are dust-proof. The weight and dimensions are no greater than of the ordinary type of universal joints.

HEIGHT GAGE: Louis Mastrangal, 35 Spring St., West Hoboken, N. J. This instrument is designed to provide means whereby the distance between a stationary surface and a given point outside of it may be accurately determined. It consists of a base carrying an upright, which in turn carries the gage mechanism proper.

"HIGHPOWER" TWISTED DRILL: Pratt & Whitney Co., Hartford, Conn. This is a flat twisted drill with a twisted taper shank and is practically the same as the Hackett twisted drill shown in the October, 1908, issue of MACHINERY. Another convolution has been added to the shank, however, to increase the holding power in the socket.

LINE OF POPPET DROP HAMMERS: Miner & Peck Mfg. Co., New Haven, Conn. These hammers are adapted particularly for silverware, jewelry and similar light stamping work, and are used as plain drops, controlled by the foot or hand, and operated by the maker's lifting pulley, or automatic lifter. The four-poppet drop is made in five sizes of 50, 100, 150, 200 and 300 pounds, respectively, and the six-poppet in five sizes of 300, 350, 500, 600 and 800, respectively.

GASOLINE HEATING TORCH: Volcano Torch & Mfg. Co., Erie, Pa. This torch is intended for making or releasing shrinking fits of various descriptions, extracting broken taps and drills, brazing, straightening shafts and similar work between lathe centers, annealing, hardening and tempering tools, and for repair work in general. Pieces three inches in diameter can be heated to a red heat in from ten to fifteen minutes. The torch can also be used for illuminating by changing the burner plug.

UNIVERSAL PLATE, BAR AND ANGLE SHEAR: Covington Machine Co., Covington, Va. This machine is adapted both for boiler-makers and structural shops. The location of the angle shears permits right or left angles of even or uneven legs to be cut to any angle up to 45 degrees. The clutch mechanism is positive and stops the knives at the highest point of the stroke. A table and gages are provided for the double angle shear for cutting different angles. Bars may be cut in either the angle or plate shear.

GEAR TOOTH GRINDER: G. W. Baker Machine Co., Wilmington, Del. This machine is intended for grinding the teeth of cast spur and bevel gears, as well as of racks. The grinding head carries a wheel of a shape to suit the gear tooth to be ground. The machine is adapted for spur gears up to 36 inches in diameter, and an attachment is furnished for holding bevel gears at any required angle while being ground. The work is indexed by use of a tooth rest engaging with one tooth in the gear while another tooth is being ground.

HOB GRINDING ATTACHMENT: Brown & Sharpe Mfg. Co., Providence, R. I. This attachment, used on the company's No. 13 universal and tool grinding machine, is intended for accurate sharpening of spirally fluted hobs by grinding the faces of the teeth. The mechanism for revolving the hob resembles in design that of the spiral head used on universal milling machines. Hobs with from two to twenty grooves can be ground, index plates being furnished for indexing within these limits.

SCREW DRIVER: Lynn Tool Forging Co., 260 Maple St., Lynn, Mass. This tool consists of a very substantial handle and is provided with blades specially forged and inserted by a locking arrangement so that the screw driver cannot work

loose from the handle, and the annoyance usually met with on this score is eliminated. Three blades of different lengths and widths are provided with each handle. The blades are forged from square stock so that a wrench can be used on the screw driver if necessary.

SAND BLAST NOZZLE: Walter Macleod & Co., Cincinnati, O. This nozzle largely overcomes the expense and annoyance in connection with the use of sand blast, due to rapid wear of the nozzles. By a special construction a film of air is interposed between the sand and the nozzle, which in an effective manner prevents undue wear. The device works by suction, and the sand reservoir may be placed at any convenient point, as the nozzle will elevate the sand to a point up to 50 feet above the sand tank.

UNIVERSAL SHEAR: C. C. Wais Machine Co., Cincinnati, O. This machine is designed particularly for boiler makers and structural iron workers for cutting plates, bars and angles of even and uneven lengths of legs. The changes required and the loss of time incident to cutting angles or plates on an ordinary punching and shearing machine are eliminated. The machine is built in five sizes, the largest adapted for angles 6 x 6 x 1 and 7 x 7 x ¾ inch, and to cut plates ⅞ inch thick. The smallest will take angles 3 x 3 x ½ and 4 x 4 x ⅜ inch, and will cut ¼-inch plates.

BLUE-PRINT WASHING MACHINE: Williams, Brown & Earle, Philadelphia, Pa. This machine is intended to accompany the makers' blue-printing machine mentioned in the August issue of MACHINERY. The machine is attached to a water pipe and takes care of the blue-prints as they come from the printing machine, washing them and passing them over a gas drying arrangement; the prints can then be delivered at the rear either separately or in a continuous roll. In connection with the electric blue-printing machine referred to, four feet of prints can be printed, washed and dried per minute.

DOUBLE CRANK PRESS: E. W. Bliss & Co., 5 Adams St., Brooklyn, N. Y. This machine is designed for accurate cutting and punching operations extending over the entire width of large sheets which are fed through the machine from front to back. The safe working capacity of the machine is from 100 tons for operations requiring great rigidity, up to 140 tons for less particular work. The machine can be provided with an automatic feed for sheets from 6 to 10 feet wide and up to 40 inches long. It is driven by a direct connected 10 H. P. motor and makes 18 strokes per minute.

HYDRAULIC BEAM SHEAR: Watson-Stillman Co., 192 Fulton St., New York City. This machine is designed for cutting I-beams, channels, flat bars, angle irons and other structural shapes, and may be used for cutting round sections in emergencies by removing the regular cutting mechanism. It can also be readily converted into a powerful hydraulic press for general work. The machine is made in two sizes to take beams and sections having the longest dimensions 15 and 24 inches, respectively. It is hydraulically operated. The weight of the smaller size shear is 12,000 pounds, and that of the larger, 16,500 pounds.

AUTOMATIC TWO-JAW CHUCK: Cleveland Chuck Co., 514 Garfield Bldg., Cleveland, O. This chuck is intended as a substitute for the old style box chuck. It is mechanically operated, but its action is similar to that of a pneumatic chuck, while the expense of installing and maintaining an air supply system is eliminated. The gripping action is accomplished by a rocking movement of the jaws, effected by the spreading of the rear ends by the axial movement of a conical collar. One pair of jaws is required for every 1/16 inch difference in diameter of the work, but the device is so designed that the change for different sizes is very quickly made.

DRILL PRESS WITH UNIVERSAL TABLE: Robertson Drill & Tool Co., Department 5, Buffalo, N. Y. This machine, known as the tilting table drill press, is provided with a table which can be swung to any position in the vertical plane. It is operated by worm and worm gear, and graduations up to 90 degrees are provided so that the table can be set accurately to a given angle. After the table has been swung into an angular position it can be turned on its center bearing so as to bring the work to any position under the drill. It can be tilted over to either side of the knee, and clamping bolts are provided to secure it firmly in any position.

MACHINE FOR TESTING HARDNESS OF METALS: Tinius Olsen & Co., 12th and Buttonwood Sts., Philadelphia, Pa. This machine is designed for use in every-day shop practice for testing the hardness of locomotive tires and other material entering into locomotive construction. The test is made by means of the Brinell method, using a ball which is subjected to a standard pressure for different materials. A dial is provided where the amount of penetration of the ball in the material tested may be read off directly without calculations. To make a test with this machine requires less than a minute, including the time necessary for inserting and removing the test specimen.

TRANSMISSION DEVICES: Carl M. Wheaton, 9 Callender St., Providence, R. I. The devices brought out include a self-oiling bearing in which the oiling device consists of a number of cork balls contained in tubes and held in contact with the shaft by their buoyancy or inclination to float on the oil; a method of hanging shafting in rooms with high ceilings, consisting of brackets holding a pipe which in turn supports the hangers; a clutch pulley where centrifugal action is made use of for throwing out a counter-weight holding the friction surfaces out of contact except when forced into position by the clutch lever; and a loose pulley with special oiling arrangement.

HYDRAULIC COPING MACHINE: Watson-Stillman Co., 192 Fulton St., New York City. This machine, designed for trimming structural shapes, small pieces of plate metal, bar iron, etc., is especially intended for use in steel mills, shipbuilding plants, and structural iron, boiler and locomotive shops. It is operated by hydraulic pressure and consists essentially of a heavy steel beam or lever actuated from the rear, and having the forward end fitted with shearing knives. The construction offers a large number of cutting combinations, the change from any one of which can be made in less than a minute's time. The machine is operated by a foot lever. The total weight of the machine is 4,700 pounds.

TESTING MACHINE OF 1,200,000 POUNDS CAPACITY: Tinius Olsen & Co., 12th and Buttonwood Sts., Philadelphia, Pa. This testing machine has been designed for the new testing labaratory of the Rensselaer Polytechnic Institute of Troy, N. Y. The method of weighing the load is a departure from all previous methods. The pressure in the main cylinder is transmitted to a diaphragm, which is exactly 1/25 of the area of the main press cylinder. The pressure on the diaphragm is communicated to a lever system terminating in a standard dial vernier screw beam. As the transmission of pressure through the diaphragm is frictionless, the amount of pressure is thus weighed with great accuracy.

DOUBLE SEAMER FOR CANS: Charles Leffler & Co., 49 Clymer St., Brooklyn, N. Y. This machine, known as the No. 21 double head automatic square double seamer, will simultaneously double seam the top and bottom to the body of square and irregular cans, such as cocoa cans, powder cans, etc. The machine is entirely automatic and can be operated by one man. All that is required of the operator is to put the cans on and off of the machine and press the treadle. Despite the complicated movements required, the machine works as easily as single end machines, and runs at the same speed. It will take work up to 8 inches wide and 12 inches high. It is possible to double seam more than 10,000 can ends, of certain shapes, per day.

STEAM TURBINE: E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. This steam turbine is the outcome of several years of experimenting; as far as possible the weaknesses of other turbines have been avoided, and structural strength is one of the main features of the design. The steam is expanded completely in the nozzles, so that there is no difference in pressure between the buckets in the wheel and the reversing chamber, and consequently no loss from leakage. This makes it possible to run with a very large clearance without the primary losses in efficiency common in most turbines and caused by steam friction and leakage. The turbine is made in types for operating both condensing and non-condensing, and also to run on exhaust steam from reciprocating engines.

SPEED REDUCER: Foote Bros. Gear & Machine Co., 44 No. Carpenter St., Chicago, Ill. This device is designed for driving machinery running at relatively low speeds from a source of power running at a high speed. The speed reducer known as style D is particularly adapted for high reduction ratios, and will give any reduction of speed up to 60 to 1. These reducers can be furnished in seven sizes, in capacities from 1 to 50 H. P. The reduction of speed is obtained through spur gears, but the design provides for elimination of the usual objections to a spur gear speed reducer in that sufficient central support of the shaft between the high and low speeds is provided. There are no rotating parts in the interior that can get out of balance and cause vibration.

FLAME WELDING OUTFIT: Schaap Flame Utilities Corporation, 344 Cumberland St., Brooklyn, N. Y. This apparatus is designed for the purpose of fusion welding cast iron, aluminum and other metals by the heat generated by combustion of the illuminating gas. The special novelty of the device is the torch. A mixture of gas and air under high pressure is sent through the tip in the center of the torch, thus generating the heat for melting the metal to be welded. A mixture of gas and air under low pressure is forced through openings of the torch which surround the central nozzle and this mixture protects the central jet from the outside atmosphere; for this purpose the torch is composed of five tubes, one inside of the other, with a space between each for the low-pressure gas to pass through.

DRILLING AND MILLING MACHINE: W. B. Knight Machinery Co., 2019-2025 Lucas Ave., St. Louis, Mo. This machine, known as the No. 2 Knight drilling and milling machine, is designed with the object in view of furnishing a machine on which a great variety of both drill press and vertical milling machine work can be done. It is built along the same lines as the original Knight machine, but is intended for much heavier duty. The machine is particularly advantageous to use upon work which requires drilling, boring and milling op-

erations which ought to be done at a single setting of the work. In this way greater accuracy is obtainable, and a considerable saving in time is effected. The table of the machine can be tilted, and is mounted so as to permit of rapid adjustment. This permits some of the operations required to be performed at an angle with some of the other operations.

IMPROVED PIPE MACHINE: Bignall & Keeler Mfg. Co., Edwardsville, Ill. This machine is designed for cutting off and threading pipe from 2½ to 8 inches inclusive, and has been constructed with a view of eliminating rocking gears and clutches. The speeds are obtained through a gear box and a compound sliding gear on one of the shafts, a speed plate attached to the box showing how to obtain the speeds for the various sizes of pipe. A single driving pulley is used, and the belt speed, consequently, is constant. The die-head is of the "low-down" type, placing the handles and die lever within easy reach of the operator, and is equipped with a special adjusting mechanism, making it very simple to operate. The chucks are of the independent type, each having three jaws, and the jaw slides are graduated and easily set to any required size of pipe. On the rear chuck, the slides are provided with flange grippers in addition to the regular pipe grippers, so as to hold flanged work. The pipe grippers are of hardened steel, are dove-tailed into the ends of the slides, and can be removed and sharpened.

* * *

HEAVY TRAINS ON THE VIRGINIAN RAILWAY

The Virginian Railway, built by the late H. H. Rogers, is probably the most carefully engineered railway in the United States, if not in the world. It was planned with the idea of making a locomotive utilize its maximum hauling capacity from the coal fields in the Alleghanies to Tidewater. It was recently announced that 80 cars of 100,000 pounds capacity each had been hauled from Alleghany summit to Tidewater, the total weight of the cars being 4,310 long tons. This record was soon beaten by a train of ninety cars loaded with 100,000 pounds, drawn by a single Mikado type locomotive. The total weight of the train approximated 7,000 tons. The maximum adverse grade is about 0.2 per cent, compensated. The grades are such that the empty cars can be hauled back to the mines by a single locomotive in trains equivalent in length to the loaded trains. That is, a locomotive that is able to handle ninety cars to Tidewater is able to haul the empty cars back to the mines.

* * *

PERSONAL

Herbert L. Beeler has been appointed advertising manager of the R. K. Le Blond Machine Tool Co., Cincinnati, Ohio.

C. W. Wrenshall, superintendent of the Western Steel Car & Foundry Co., has been made general superintendent of the Pressed Steel Car Co., Pittsburg, Pa.

H. E. Longwell has been appointed consulting engineer with particular jurisdiction over the publicity department of the Westinghouse Machine Co., East Pittsburg, Pa.

W. A. Bole has been appointed assistant manager of the works of the Westinghouse Machine Co., East Pittsburg, Pa., with particular jurisdiction over the Trafford Works.

Otto J. Rantz, formerly in charge of the shop work at the Haverford College, Haverford, Pa., has been appointed superintendent of the Stephens Industrial School, Lancaster, Pa.

John Scott, a contributor to MACHINERY, recently was promoted to the position of factory inspector of the Tomson Co., Lowell, Mass.

H. L. Mills, president of the American Specialty Co., Chicago, has just returned from an extensive business trip through the East.

Hiram Pruim, for nearly ten years in the employ of the William Hahn Co., Chicago, makers of flexible shafts, has been made superintendent.

J. E. Stark, formerly with the Courier Koeth Mfg. Co., has accepted a position as superintendent of the Western Wire Goods Co., of Buffalo, N. Y.

R. L. D. Mackie, formerly with the Morgan Construction Co., Worcester, Mass., is now manager of the high pressure and pipeage department of the W. J. Scholl Co., Youngstown, Ohio.

W. S. Heger, of the Allis-Chalmers Co., who was formerly assistant to the president, has been placed in charge of the company's interests in southern California, with headquarters at Los Angeles.

Harold O. Rugg, a graduate of Dartmouth College, and now in the employ of the Missouri Pacific Railway, has been appointed instructor in civil engineering in the James Millikin University at Decatur, Ill.

S. H. Reck, of the Rockford Drilling & Machine Co., Rockford, Ill., sailed from New York August 26 on the *La Lorraine* for a two months trip in Europe. Mr. Reck expects to visit the various machine tool agencies in England and on the continent.

F. C. Armstead, supervising engineer of the stoker department of the Westinghouse Machine Co., who, for a number of years, has been located at East Pittsburg, Pa., has moved his headquarters to the Westinghouse Works, Attica, N. Y., where the stokers are manufactured.

Charles M. Robertson, formerly superintendent of the Colburn Machine Tool Co., Franklin, Pa., will henceforth be associated as special representative and expert with the E. L. Essley Machinery Co., 62 West Washington St., Chicago, selling agent for the Colburn Machine Tool Co. Mr. Robertson has a large and varied experience in the manufacturing and selling of vertical boring mills.

W. R. Chapin, who has been for five years connected with the Cleveland Twist Drill Co., Cleveland, Ohio, has engaged with E. C. Atkins & Co., saw manufacturer, Indianapolis, Ind. While with the Cleveland Twist Drill Co. Mr. Chapin was in charge of the chemical laboratory, heat treatment and experimental departments, and will have a similar position with E. C. Atkins & Co.

Charles T. Hawley, of Gardner, Mass., has been appointed assistant examiner in the patent office at Washington, and has, therefore, resigned from an important position with the Simplex Time Recorder Co., of Gardner, Mass. Mr. Hawley has been active as an inventor, and was formerly connected with the experimental department of the Draper Machine Co. of Hopedale, Mass. He graduated in 1898 from the Worcester Polytechnic Institute.

E. H. Fish, well known to the readers of MACHINERY as a frequent contributor to its columns, has been elected director of the new Worcester Independent Industrial School. For nine years Mr. Fish was associated with his father, Henry C. Fish, in the machine tool manufacturing business in Worcester, producing a line of engine lathes. Later he went to the Worcester Polytechnic Institute—from which he graduated in 1892—as instructor. He has been instructor in various subjects, and his experience in this work make him particularly fitted to take charge of a trade school designed primarily for the education of mechanics.

* * *

OBITUARIES

T. H. Sears, builder of machinery, Holyoke, Mass., died July 30, aged fifty-eight years.

Fred W. Ridlau, treasurer of the Superior Grate Co., of Springfield, Mass., died July 27 at the age of thirty.

Levi M. Brown, who for more than thirty years was superintendent of the Gilbert & Barker Mfg. Co., Springfield, Mass., died July 15 at the age of seventy-three.

John Moore, superintendent of the machine shops of the Carnegie Steel Co., at Bellaire, Ohio, died by accident at Wheeling, W. Va., July 26.

Henry Mitchell, well-known as an engraver of seals, medals and coats of arms, died at his home in Chelsea, Mass., August 1, in his seventy-fourth year. He entered the service of the United States Government as official engraver in 1868, and engraved the medals for the Centennial Exposition, 1876, before he was thirty years old.

John Morse Ordway died at his home in Saugus, Mass., July 5, at an age of eighty-six years. He was a graduate of Dartmouth College in the class of 1844, and was, up to three years ago, professor at Tulane University, New Orleans. He has also been a member of the faculty of the Massachusetts Institute of Technology.

David H. Gildersleeve, mechanical engineer, died at his mother's home, 104 Montague St., Brooklyn, July 30, aged forty-one. For five years Mr. Gildersleeve was sales manager for the C. W. Hunt Co. Early in 1909 he became vice-president of the Waters, Gildersleeve, Colver Co., in the shipbuilding and marine machinery business. He is survived by a widow and two children.

Leffert Lefferts Buck, a well-known civil engineer, who was associated with Roebling in the building of the Brooklyn bridge, and who was engineer of the Williamsburg bridge across the East River, New York, died at Hastings, N. Y. July 17. Mr. Buck also designed two steel arch bridges across the Niagara river, and had direction of many other engineering works of note both in this country and South America.

Roderick Perry Curtis, president of the Curtis & Curtis Co., Bridgeport, Conn., died at Southport, Conn., August 9, aged fifty-nine, as a result of injuries received in an automobile collision at Westerly, R. I., a few weeks previous. Mr. Curtis was born in New York, from where his family moved to Southport, Conn., in 1868. In 1882 he founded, with William D. Forbes, the firm of Forbes & Curtis, for the manufacture of the Forbes patent die stock. In 1887 the Forbes interests were taken over by Mr. Lewis B. Curtis and the firm of Curtis & Curtis formed to continue the business. In 1900 the firm was incorporated under the name of the Curtis & Curtis Co. Mr. Curtis was also director of several other manufacturing corporations.

Albert A. Pope

Albert A. Pope, pioneer bicycle manufacturer of the United States, died at his summer home in Cohasset, Mass., August 10. He was born in Boston in 1843, and at the age of nineteen he joined the volunteer force of the Union army, and was made lieutenant-colonel in 1865. In 1876, at the Centennial exposition in Philadelphia, he first saw a bicycle. Early in 1877 he organized the Pope Mfg. Co., and as soon as the company was organized he went to Europe to study the development of the bicycle and its possible manufacture in America. In 1878 he placed an order for the manufacture of bicycles with the Weed Sewing Machine Co., which concern he finally bought out, merging it with the Pope Mfg. Co. The business grew rapidly until, after twenty years, it comprised five large factories. In 1896 Col. Pope formed the Columbia Electric Vehicle Co., of Hartford, Conn. In 1899 the Pope Mfg. Co. was absorbed by the American Bicycle Co., but in 1903 the Pope Mfg. Co. was re-organized, and the factories became largely devoted to the building of automobiles. A lull in the motor car business proved unfortunate for the company, and after a period of financial readjustment, the company was again reorganized and incorporated last December under the laws of Connecticut. Col. Pope was prominent in many other industrial undertakings, and was also a director of several banks and other corporations.

Frank L. Bliss, president of the Ajax Iron Works, Corry, Pa., died in Corry, August 3. Mr. Bliss was active in the management of the company since its organization.

* * *

COMING EVENTS

September 14-16. Fourteenth annual convention of the International Association of Municipal Electricians, Atlantic City, N. J. Frank T. Foster, secretary, Corning, N. Y.

September 25-October 9.—Hudson-Fulton celebration of the three-hundredth anniversary of the discovery of the Hudson River by Hendrick Hudson in 1609, and the one-hundredth anniversary of the successful application of steam to the navigation of the Hudson River in 1807. The headquarters of the commission are in the *Tribune* building, New York City, General Stewart L. Woodford, president, and Mr. Henry W. Sackett secretary. The commission solicits the loan of collections of machinery, models, books, etc., having a bearing on the history of early steam navigation in the United States.

September 27-October 1.—Autumn meeting of the Iron and Steel Institute, London. G. C. Lloyd, secretary, 28 Victoria St., London, S. W.

October 3-9.—St. Louis Centennial Week, St. Louis, Mo. Balloon, airship and aeroplane races will be arranged under the auspices of the Aero Club of St. Louis.

October 4-8.—Annual conventions of the American Street and Interurban Railway Association, American Street and Interurban Railway Accountants Association, American Street and Interurban Railway Engineering Association, American Street and Interurban Railway Claim Agents' Association, American Street and Interurban Railway Transportation and Traffic Association, American Street and Interurban Railway Manufacturers' Association, at Denver, Col. Bernard V. Swenson, secretary and treasurer, 29 West 39th St., New York.

October 12-13.—Convention of National Machine Tool Builders' Association, New York. P. E. Montanus, secretary, Springfield, Ohio.

October 14.—MACHINERY'S seventh annual outing.

April 1-June 30, 1910.—American Exposition in Berlin to stimulate trade relations with Germany and American export business generally. The exposition will be held in the Exposition Palace, having 110,000 square feet floor space. Max Viewger, American manager, 50 Church St., New York.

NEW BOOKS AND PAMPHLETS

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS, Park Row Building, New York. Journal containing the constitution and list of members.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, 29 W. 39th St., New York. Pocket list of the 3,680 members, including the life members. The list appears in a new form, better adapted to the side pocket than the former shape, it being 4¼ x 6½ inches, or "standard" pocket-book size.

DICTIONARY OF CHEMICAL AND METALLURGICAL MATERIAL. 182 pages, 4½ x 7½ inches. Published by the *Electro-Chemical and Metallurgical Industry*, 239 W. 39th St., New York City. Price $0.50.

This dictionary contains an alphabetically arranged list of chemical and metallurgical machinery appliances and material, manufactured and sold by advertisers in the *Electro-Chemical and Metallurgical Industry*. It is divided into three sections, the first or main section being a dictionary of industrial supplies, the second section giving a finding list of manufacturers of measuring instruments and laboratory supplies, while the third section is given up to a professional dictionary of metallurgical, analytical and engineering chemists, consulting engineers and patent lawyers.

WORKSHOP RECEIPTS FOR MANUFACTURERS AND SCIENTIFIC AMATEURS. VOLUME 1. 532 pages, 4¾ x 7¼ inches. Published by Spon & Chamberlain, 123 Liberty St., New York. Price $1.50.

The older edition of "Workshop Receipts" has, during the past few years, grown into five bulky volumes, and the present edition therefore has been thoroughly revised and a great number of the receipts that seemed obsolete have been omitted. The remaining matter has then been carefully revised. The arrangement of the book is alphabetical, and the present volume treats of subjects from Acetylene Lighting to Drying. Outside of the alphabetical arrangement of subjects, a very complete index is given, which will be of considerable aid in finding certain subjects which have not been given a special heading in the main text.

ELEMENTARY PRINCIPLES OF INDUSTRIAL DRAWING. By George Jepson. 29 pages, 8 x 6 inches. 11 plates of illustrations. Published by the author, Roslindale, Boston, Mass.

The object of this book is to present the subject of industrial drawing by such a method that the student will master the fundamental principles without a great deal of preliminary study. Special efforts have been made to make the descriptive matter as short, simple and concise as possible, and to let the drawings largely explain the principles involved. The book should be of great value to beginners as well as to teachers of geometrical drawing, who desire to get a clear conception of the simplicity of the subject when viewed from the position of the practical user of mechanical drawing, rather than from the point of view of the mathematician or student of the theory.

A PRIMER OF THE CALCULUS. By E. Sherman Gould. 122 pages, 3¾ x 6 inches. 24 line engravings. Published by D. Van Nostrand Co., New York. Price $0.50.

This book, which is at present in its fourth edition, is No. 112 of the Van Nostrand Science Series. The work treates of calculus as far as the first differentials of algebraic functions of one independent variable, and their corresponding integrals. It is thus restricted to the first principles of the subject, but within its limits, however, it is reasonably complete and gives the beginner a clear idea of the far-reaching importance of calculus, even in its elementary steps. The book may well be recommended to students who want to acquire a general working knowledge of calculus and desire to become familiar with its fundamental principles.

STEAM POWER PLANT PIPING SYSTEMS. By William L. Morris. 490 pages, 6 x 9½ inches. 389 engravings. Published by the McGraw-Hill Book Co., New York. Price $5.

In this work the author has taken up the design, installation and operation of piping systems for power stations, giving a detailed and consecutive treatment of the entire subject. Only such parts of the power plant are dealt with as are directly related to the piping system. The design of boilers and engines has not been touched upon, as being outside the limits of the treatise, but their operation has been covered. All auxiliary apparatus in the pipe circuit between the boiler and engine and in the various piping systems for steam, oil, air, etc., are also described, and their general design discussed. The book embodies the personal experience of the author and is written from his own point of view. The main subjects of which the book treats are as follows: Piping diagrams and systems; condensers and heaters; live steam drips; blow-off and exhaust piping; air and oiling systems; oil and water purifying systems; details of piping arrangements for live steam, vacuum and atmospheric exhaust, boiler feed, fire pump suction, heater water supply and condensation, air and vacuum lines; city water piping; artesian water piping; fire service piping; hydraulic elevator piping; tile sewers and sundry minor piping details.

CATALOGUES AND CIRCULARS

TRENTON ENGINE CO., Trenton, N. J. Catalogue illustrating the Reeves compound and single cylinder steam engines.

PROTECTIVE VENTILATOR CO., 129-133 Fulton St., New York. Circular and leaflets advertising protective window ventilators.

AMERICAN BLOWER CO., Detroit, Mich. Card advertising the Detroit trap system for boiler feed, water lift and coil drainage.

FIRTH-STERLING STEEL CO., E. S. JACKMAN & CO., agents, Chicago, Ill. Circular of Blue Chip high-speed steel.

INGERSOLL-RAND CO., 11 Broadway, New York. Catalogue describing the construction of rock drills and drill mountings.

H. W. JOHNS-MANVILLE CO., 100 Williams St., New York. Folder describing safety blow-off sectional pipe covering, giving price list and directions for applying the covering to pipes.

SUCRO FILTER CO., 42 Broadway, New York. Catalogue of Sucro water coolers and filters, and filtration plants, showing a number of interesting devices for purification of drinking water.

AMERICAN TAP & DIE CO., Greenfield, Mass. Catalogue No. 3 of "Adamantine" screw plates, "Eagle" brand taps and dies, stocks and tap wrenches; also pipe tools, comprising stocks, taps and reamers.

ABBOTT BALL CO., 14 Hicks St., Hartford, Conn. Circular describing the use of the Abbott steel balls for finishing metal goods by the burnishing and tumbling process, using the Abbott tumbling barrel.

E. W. BLISS CO., 5 Adams St., Brooklyn, N. Y. Catalogue of Bliss steam turbines, describing the construction of the Bliss turbine and calling attention to the advantages of turbines over reciprocating engines.

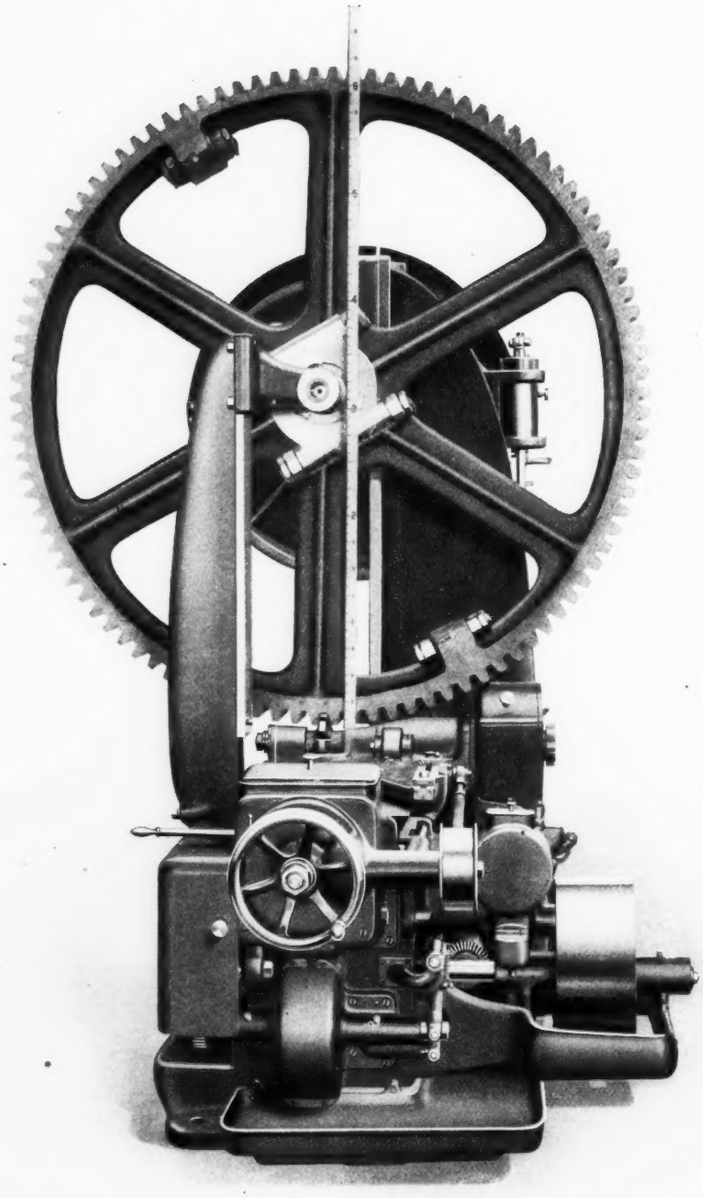
FULLER & JOHNSON MFG. CO., Madison, Wis. Circular illustrating and describing the Fuller & Johnson diaphragm bilge pump outfits. A general description of the engine and pump is given, and the cost of operation is stated.

JNO. HY. ANDREW & CO., Ltd., Toledo Steel Works, Sheffield, England. Booklet giving information relating to the Toledo high-speed steel and instructions regarding its hardening, together with notes on the forging and tempering of the regular Toledo carbon tool steel.

KEUFFEL & ESSER CO., Hoboken, N. J. Leaflet calling attention to the fact that during the summer months quick-printing blue-print paper should not be carried in stock more than one month, because the heat and moisture at this time of the year is detrimental to the paper.

GENERAL ELECTRIC CO., Schenectady, New York. Bulletin No. 4675, describing and illustrating a new single-phase induction motor of the repulsion induction type, designated as the type RI. Bulletin No. 4677, containing data relating to the Sprague-General Electric Type M system of control.

RUSSELL, BURDSALL & WARD BOLT & NUT CO., Port Chester, N. Y. Catalogue of bolts and nuts, comprising Philadelphia turned head eagle carriage bolts, turned bevel head carriage bolts, loom bolts, cold punched square and hexagon nuts, square head cap screws, machine screws, rivet heads, etc.



The Accuracy of All Gears Cut in Our Gear Cutting Department Constitutes Their Most Important Characteristic

This department is well equipped for the rapid production of all sizes of Spur Gears up to 75″ in diameter; Spiral Gears up to 38″ in diameter; and Worm Wheels up to 84″ in diameter.

The accompanying cut shows a

B. & S. No. 6 Automatic Gear Cutting Machine

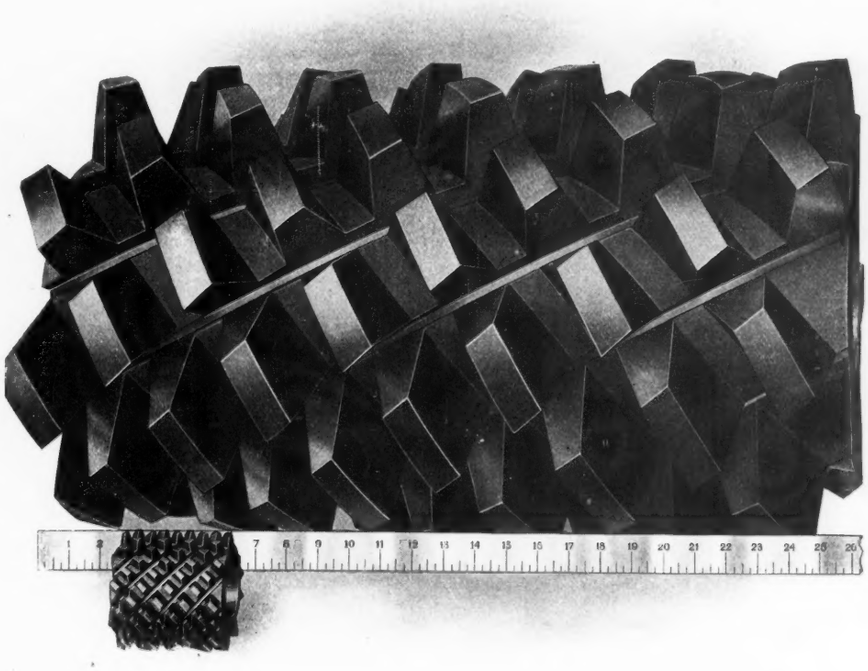
cutting a spur gear 74.81″ in diameter, 8″ face, having 102 teeth of 2.26″ pitch.

ACCURATELY CUT HOBS

By the employment of new, especially designed machinery, we are enabled to **Quickly** and **Accurately** make hobs of any diameter and length up to that of the large hob shown in the illustration, and of any pitch and lead. They can be made either on a shank or with hole; right or left hand threads.

All hobs are made with relieved teeth that can be ground on their faces without changing their form. The method of relieving enables the hobs to cut as freely as formed cutters, and to be sharpened in the same manner.

The cut below shows two good examples of hob cutting. The larger one is 15.4″ in diameter, 25⅜″ in length and has 7 right hand threads with an axial pitch of 4.00″ and a lead of 28.00″.



Send for booklet entitled "Gears," which gives a large list of gears and hobs.

BROWN & SHARPE MFG. COMPANY

PROVIDENCE, RHODE ISLAND, U. S. A.

H. W. JOHNS-MANVILLE CO., 100 William St., New York. Circular describing and giving prices of the J-M brickline asbestos firebrick cement for setting up bridge walls and inner courses in boiler settings. This cement is of a semi-liquid consistency, ready for immediate application in setting up firebrick in every kind of service.

A. BOLLINCKX, Huyssinghen, near Hal, Belgium. Pamphlet reprinted from article by Prof. François of the University of Brussels on the Bollinckx gas motors and gas producers, which first appeared in the *Revue Universelle des Mines*. The pamphlet is in French. Copies will be sent to interested parties free of charge.

REMINGTON TOOL & MACHINE CO., 50 Congress St., Boston, Mass. Circular illustrating the Remington twist drill grinding gage, coil spring winder and micrometer surface gage. The spring winder can be used in the lathe or vise and enables perfect extension, compression and torsion springs to be wound on a mandrel without other appliance.

GRAHAM MFG. CO., Providence, R. I. Circular of pressed steel grinder chucks for disk, guide bar, knife, and other face grinders. These chucks, for holding wheels for face grinders, are designed without external projections and are safe, light and simple in their construction.

W. S. ROCKWELL CO., Hudson Terminal Building, 50 Church St., New York. Folder referring to, and giving sizes of, Rockwell muffle furnaces for assaying and other work using oil or gas fuel. If oil is used the pressure may be five pounds per square inch or higher, while air at two pounds pressure is satisfactory.

HILL CLUTCH CO., Cleveland, Ohio. Pamphlet devoted to line shaft bearings, describing the Hill collar oiling bearing, and calling attention to the products of the Hill Clutch Co., consisting of power transmission machinery, rope transmission, gears, bearings, friction clutches, shafting, pulleys, belt tighteners and fly-wheels.

CLEVELAND TWIST DRILL CO., Cleveland, Ohio. Folder No. 930 illustrating and listing the high-speed "Flat-twist" drill with "Paragon" flat taper shank. This drill is twisted from a flat bar instead of being made from the round stock, and is an old design made by the company thirty-five years ago, but recently revived on account of the requirements of high-speed drilling.

HESS-BRIGHT MFG. CO., 21st and Fairmount Ave., Philadelphia, Pa. Card showing view of buildings of the new ball-bearing section of the Deutsche Waffen und Munitionsfabriken at Wittenau, near Berlin. The Hess-Bright Mfg. Co. controls the output of this plant in the American market, and also manufactures under this plant's as well as its own patents.

TRIUMPH ELECTRIC CO., Cincinnati, Ohio. Bulletin No. 371 describing the Triumph adjustable speed commutation pole motors, which are particularly suitable for machine tool drive. On account of the commutation pole construction, sparking is eliminated in these motors within the limits of the capacity of the motor. They are built in all standard sizes from ½ horse-power upward, with speed variations of 1 to 2, 1 to 3 and 1 to 4, and are capable of heavy overload.

SENECA FALLS MFG. CO., 330 Water Street, Seneca Falls, N. Y. Catalogue No. 22-B illustrating and describing the "Star" 9- and 11-inch screw-cutting engine lathes, the "Seneca Falls" 12-, 14-, and 16-inch screw-cutting engine lathes, speed lathes, wood-turning lathes, and attachments. This catalogue describes in detail the improvements introduced in the new designs of the company's machines.

HESS-BRIGHT MFG. CO., 21st and Fairmount Ave., Philadelphia, Pa. Circulars giving data relating to thrust collar ball bearings, sliding shafts journaled in rotary ball bearings, ball bearing pillow blocks, rollers mounted on ball bearings, two direction thrust bearings, inclined, vertical or horizontal shaft mountings, vertical bevel gear mounting, and pillar crane with ball bearing thrust mounting.

WOBURN GEAR WORKS, 32 Nashua St., Woburn, Mass. Catalogue of gears, sprockets, and chains, giving price list and other required information of the company's products of spur gears, bevel gears, miter gears, worms, worm-gears, pinion wire, racks, ratchets, chains, sprockets, pulleys, shafting, collars, and regular and ball bearings. The company is prepared to make all kinds of gears including rawhide and fiber gears.

CLEVELAND PUNCH & SHEAR WORKS CO., Cleveland, O. Catalogue of machines and small tools, devoted particularly to standard dies and punches, punching machines, coping machines, plate shears, bending rolls, rotary planers, etc. The catalogue also contains a number of useful tables, and a number of pages are devoted to specimen drawings of dies and punches on which the customer has only to fill in the required dimensions for the material he wants to order.

CHAIN BELT CO., Park St. and 11th Ave., Milwaukee, Wis. General catalogue No. 37 of elevating, conveying and concrete machinery, including elevators, conveyors, chains, chain belts, sprocket wheels and various attachments, gearing, pulleys, bearings, etc. A line of concrete chain-belt mixers is also included. The catalogue comprises 303 pages printed on coated paper and handsomely bound. It is well indexed and is therefore conveniently used for reference.

GISHOLT MACHINE CO., Madison, Wis. Circular describing micrometer index dials and automatic feed trips used on Gisholt boring mills. The time-saving features of these attachments will at once appeal to the shop man. By means of the automatic feed trip either head of the machine may be set to a given trip at a given point, and the operator may attend to other work in the meantime with absolute confidence that when the desired point in the cut has been reached, the feed will stop automatically.

CINCINNATI ELECTRICAL TOOL CO., 650-652 Evans St., Cincinnati, Ohio. Catalogue of "Peerless" portable electric drills, reamers, and grinders, illustrating the line and uses of same. The tool-post grinders made for both internal and external work are of particular interest to the machinist. These electrically driven grinders are mounted in the tool-post of an engine lathe, planer or shaper, and thus convert standard machine tools into fairly efficient grinding machines for circular or flat work.

NEW YORK LEATHER BELTING CO., 51 Beekman St., New York. Pamphlet entitled "From Forest to Factory," containing a description of balata and balata belting. Balata is the milk of the boela tree from Guiana and Venezuela. The pamphlet contains interesting information regarding the gathering of balata and the manufacture of balata belting. It illustrates a number of interesting installations, many of which are very trying to belting in general. A perusal of the pamphlet will repay all who are concerned with the problem of power transmission. Sent free on request.

WALTON CO., Hartford, Conn. Circular illustrating and describing the Walton extractor for broken taps. This device consists principally of four prongs or fingers of crucible steel, shaped to fit the flutes of the tap and adjustably mounted in a grooved holder which is squared on its outer end for a tap wrench. When a broken tap is to be removed the four fingers are pushed into the flutes after some of the chips have been removed, and the tap is then screwed out by applying a wrench at the outer end of the tool.

NELSON VALVE CO., Chestnut Hill, Philadelphia, Pa. Catalogue of bronze valves, iron-body and steel valves, and accessories and fittings. This catalogue lists a great number of different types of valves, including combination globe and angle valves; cup, vertical and swing check valves; union bonnet globe, angle and cross valves; bronze, iron and steel gate valves; gate valves hydraulically, electrically and gear-operated; and valve wheels, disks, floor stands, steel fittings, companion flanges and drilling standards. The catalogue is printed on heavy coated paper and handsomely bound in cloth. It is provided with a complete index, making it convenient for reference purposes.

GENERAL ELECTRIC CO., Schenectady, N. Y. Booklet No. 3839 illustrating and describing 8- and 12-inch fans for alternating and direct current. Bulletin No. 4665, entitled "Electric Operation of Pulp and Paper Mills," illustrating the application of the electric motor to the paper industry. Bulletin No. 4688 describing a new meter board made of molded material intended to replace the customary wooden board used in mounting meters. Bulletin No. 4680, entitled "Sign Lighting with Tungsten Lamps." A small folder and a booklet have also been issued relative to the new G. E. tungsten lamps.

WATSON-STILLMAN CO., 192 Fulton St., New York. Catalogue No. 74 on the Watson-Stillman hydraulic beam shear and the Watson-Stillman hydraulic coping machine. The beam shear has cutting blades which first penetrate the web and are then deflected sidewise by means of a wedge, thus cutting the flanges of the beam last. The hydraulic coping machine is employed for trimming structural shapes, cutting out sections from the flanges, and doing other work necessary in the joining of structural shapes in steel mills, ship building plants, structural iron, boiler and locomotive shops, and wherever splices, connections or cuts are required.

AMERICAN OIL AND SUPPLY CO., 52-56 Lafayette St., Newark, N. J. Catalogue No. 1 of fine tools, machinery, supplies and specialties for jewelers, silversmiths, dentists, opticians, engravers and metal workers. This is a large cloth-bound catalogue of 638 pages, listing the complete line of the goods which the company handles. A carefully prepared index makes it easy to find any matter to which one wants to refer. The tools listed which will be of particular interest to the machinery trade are, among others, blow pipes, micrometers, calipers and caliper squares, oil stones, drill chucks, dividers, drills, emery wheels, files, flexible shafts, countershafts, gas forges and melting furnaces, gages of various descriptions, grindstones, hammers, etc. The catalogue has been compiled by Mr. H. M. Crouse, of the Henneberry Co., Chicago.

MANUFACTURERS' NOTES.

CROCKER-WHEELER CO., Ampere, N. J., will open an office in the Ford building, Detroit, Mich., about September 10. Mr. Charles W. Cross will be the manager of this branch.

MURALT & CO., engineers, 114 Liberty St., New York, have been awarded the contract for furnishing and installing the electric equipment of the new municipal lighting and pumping plant at Berlin, Md.

GENERAL ELECTRIC CO., Schenectady, N. Y., is now making tantalum lamps adapted for voltages from 200 to 250. The tests undertaken have shown satisfactory results, the life of the new lamps averaging fully that of the regular 100- to 130-volt tantalum lamps.

ELECTRICAL ALLOY CO., Morristown, N. J., has been organized for the manufacture of electric resistance materials. The officers of the corporation are H. P. Reigart, president; F. S. Reigart, secretary and treasurer; and William F. Smith, general manager.

CINCINNATI IRON & STEEL CO., Cincinnati, Ohio, district sales agent for the Lackawanna Steel Co., is improving its present warehouse equipment; it is installing a large machinery warehouse and remodeling its office building situated at the corner of Front and Freeman Sts.

INTERNATIONAL ACHESON GRAPHITE CO., Niagara Falls, N. Y., is enlarging the capacity of its branch works at Niagara Falls, Ont. A new furnace room, providing for a 1,000 horse-power unit is being built, and upon completion of this, the new installation will be put in operation.

W. M. Nones, 27-29 Water St., New York, who represents American machinery and machine tools in Europe will return to England in October. Mr. Nones is in a position to handle one or two more specialties for American manufacturers, especially labor-saving devices and machines.

CUTLER-HAMMER MFG. CO., Milwaukee, Wis., maker of electric controlling devices, announces the opening of a Philadelphia office at Room 1207, Commonwealth Building. An engineer specially qualified to advise regarding the control of electric motors will be in charge of the new office.

F. S. WALTON CO., Philadelphia, Pa., manufacturer of Oxoilox belt dressing, reports that this dressing is attaining a wide sale abroad, and that one firm in Russia alone orders four barrels a month. This belt dressing contains as its basic ingredient neatsfoot oil, which is one of the best materials for keeping belts pliable.

FRANK B. GILBRETH, 60 Broadway, New York City, has been awarded the contract for the construction of a hydro-electric power development across Paulin's Kill, Columbia, N. J., for the Warren County Power Co. The contract includes the construction of a Ransom hollow dam, 30 feet high and 350 feet long, and a reinforced concrete power house and tail-race.

COLBURN MACHINE TOOL CO., Franklin, Pa., builder of vertical boring and turning mills, will, after September 1, be represented in the Chicago territory by the E. L. Essley Machinery Co., 62 West Washington St., Chicago. Mr. Charles M. Robertson, formerly superintendent of the Colburn Machine Tool Co, will be associated with the Essley Co. as special representative and expert. A representative line of boring mills will be carried in stock in Chicago, and machines will be shown in operation.

WESTINGHOUSE STORAGE BATTERY CO., Boonton, N. J., was incorporated July 12th, and has acquired all of the plant, patents and equipment of the storage battery department of the Westinghouse Machine Co., and of the General Storage Battery Co., and will manufacture both the Westinghouse and Bijur types of storage battery for those classes of service in which each has proved superior. The general offices of the company will be located at Boonton, N. J., with sales offices in the principal cities of the country.

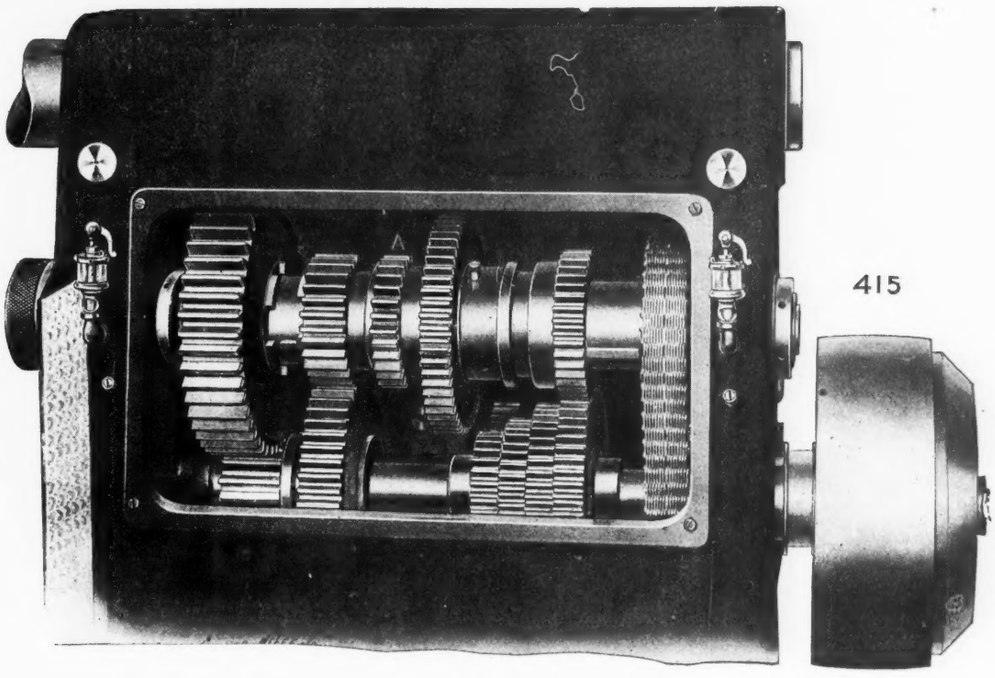
FRANK MOSSBERG CO., Attleboro, Mass., has begun building a new factory, consisting of a main building 290 x 60 feet and a power building 150 x 60 feet. The new factory will employ over 250 men, and is to cost $50,000. The factory building is a two-story brick building, the lower floor being used entirely for the presses and heavy machinery, and the second floor for light manufacturing purposes, tool making, and assembling, as well as for office and drafting room. The company's main product is metal-stamping work of all kinds.

CROCKER-WHEELER CO., Ampere, N. J., has recently booked several large orders for direct current apparatus, including one from the Indiana Steel Co., calling for seventy mill motors totaling about 2,400 H. P. This order is an addition to the 11,000 H. P. of Crocker-Wheeler motors employed at the present time by this steel company. The Bethlehem Steel Co. has recently added to 8,800 H. P. of Crocker-Wheeler motors by an order for a 225 H. P. compound wound motor to be installed at the Saucon plant.

T. R. KILLILEA, 229 West 101st Street, New York City, has developed a new belt dressing consisting of a "processed" vegetable oil which preserves the fiber, not having the rotting effect of neatsfoot oil. It contains no resin or gum, and is particularly well adapted for use in textile mills, factories, shops and other places where it is highly necessary that no stain or grime be cast on the fabrics by the belts. The Killilea dressing does not stain fabrics even if directly applied as it can be washed away with a little soap and warm water.

MANUFACTURERS' PUBLICITY CORPORATION has been organized by Benjamin R. Western and W. Hull Western (until August, 1909, proprietor and manager, respectively, of the Manufacturers' Advertising Bureau) and Walter Mueller and W. H. Denney, president and treas-

Simplicity, Handiness, Efficiency



CINCINNATI HIGH POWER MILLERS

(Horizontal and Vertical)

have the following exclusive features which make for greater production:

ALL GEARS OF STEEL with teeth of standard length, 20° pressure angle.

NO GEARS ever in mesh except those needed for the speed being used.

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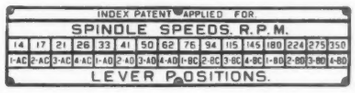
THE SPEED INDEX is truly direct-reading, simplest possible form.

THE TREADLE makes speed-changing quick and easy.


INDEX PATENT APPLIED FOR.
SPINDLE SPEEDS. R.P.M.
14 17 21 26 33 41 50 62 76 94 115 145 180 224 275 350
1-AC 2-AC 3-AC 4-AC 1-AD 2-AD 3-AD 4-AD 1-BC 2-BC 3-BC 4-BC 1-BD 2-BD 3-BD 4-BD
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urer, respectively, of the Banning Co. The new corporation will take charge of the advertising interests heretofore directed by the two companies. The offices are located in the Hudson Terminal Building, 30 Church St., New York.

GANDY BELTING CO., Baltimore, Md., has completed a four-story addition to the present plant, and has now what is claimed to be the largest factory in the world devoted to the manufacture of cotton duck belting. The new building is 110 by 104 feet, and is of slow burning New England mill construction with fire-proof stairways, metal window frames and wire glass windows, so as to provide protection in case of fire in surrounding buildings. The new building was erected, designed and equipped by McLaughlin Bros., engineers and constructors, of Baltimore and Philadelphia.

B. F. STURTEVANT CO., Hyde Park, Mass., has been reorganized and recapitalized. The new corporation is organized under the laws of Massachusetts and its capital is increased from $500,000 to $1,250,000 six per cent cumulative preferred stock, and $1,250,000 common stock. John Carr is president; Eugene N. Foss, treasurer, and E. B. Freeman, general manager. The increased capitalization represents capital expenditures during the past year largely in the erection of a new plant at Hyde Park which cost over $1,500,000. The company is doing a business of about $3,000,000 per year.

WESTERN ELECTRIC CO., 463 West St., New York, has obtained a contract from the Chinese Government to supply a complete telephone plant for Pekin. Two exchanges have been ordered, but this is only considered as the beginning of a system which will eventually be fully developed throughout China. The order covers a complete telephone plant of modern type, including several hundred thousand feet of lead-covered aerial and under-ground cable. The order amounts to about $150,000, and the work of installation will be done under the supervision of one of the Western Electric Co.'s engineers, who will be sent to Pekin for that purpose.

MISCELLANEOUS

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

ACTIVE PARTNER WANTED.—Owner of plant located in large city in the Middle West, manufacturing hoisting machinery, brick-making machinery, pumps and other special lines, desires to withdraw from active business. Will sell all or part of his holdings to right man on very liberal terms. Address Box 224, care MACHINERY, 49 Lafayette St., New York.

AGENTS IN EVERY SHOP WANTED to sell my sliding Calipers. Liberal commission. ERNST G. SMITH, Columbia, Pa.

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DRAWINGS, TRACINGS, ETC., MADE.—Prices reasonable. Box 1302, Orange, Mass.

FOREMAN FOR MACHINE SHOP employing about 75 men on plain lathe turning, ornamental iron assembling and smith work. We want a man of executive ability, with some knowledge of system; a good organizer and capable of getting maximum machine output on piece price basis work. Must have good recommendations. Address L. M. J., care of MACHINERY, 49 Lafayette St., New York.

FORMULAS AND TABLES FOR SHOP AND DRAFTING ROOM is No. 35 in MACHINERY'S Reference Series, and for practical use in mechanical work promises to be the most widely useful book published in years. See four-page advertisement in this number. Price 25 cents. Address MACHINERY, 49-55 Lafayette St., New York City.

LATHE, PLANER AND BORING MILL HANDS WANTED for night and day shift. No labor troubles. Increasing force. Applicants must state wages desired, past experience and if employed at present, to receive further consideration. Apply to INGERSOLL-RAND CO., Painted Post, New York.

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ON ACCOUNT of extensive alterations in our building, we have for sale two five-story automobile elevators, practically new; original cost $4,500 each. One of these elevator platforms in first-class condition. Elevators can be seen and particulars obtained at 1733 Broadway, New York City.

PATENTS.—H. W. T. Jenner, patent attorney and mechanical expert, 608 F Street, Washington, D. C. Established 1883. I make an investigation and report if a patent can be had and the exact cost. Send for full information. Trade-marks registered.

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SUPERVISOR OF LABOR for factory employing 500 men. Fine machine tools. Must be specially qualified to handle all matters pertaining to the employment and efficiency of labor. State age and education and give full particulars regarding experience, especially during the last five years. Address Box 226, care MACHINERY, 49 Lafayette St., New York.

USE OF FORMULAS and of Tables of Sines and Tangents, without a knowledge of Algebra or Trigonometry, is made easy to you by SHOP ARITHMETIC FOR THE MACHINIST, which is No. 18 in MACHINERY'S Reference Series described in four-page advertisement in this number. MACHINERY, 49-55 Lafayette St., New York City.

WANTED.—Agents, machinists, toolmakers, draftsmen, attention! New and revised edition Saunders' "Handy Book of Practical Mechanics" now ready. Machinists say "Can't get along without it." Best in the land. Shop kinks, secrets from note books, rules, formulas, most complete reference tables, tough problems figured by simple arithmetic. Valuable information condensed in pocket size. Price postpaid $1.00 cloth; $1.25 leather with flap. Agents make big profits. Send for list of books. E. H. SAUNDERS, 216 Purchase St., Boston, Mass.

WANTED.—SUPERINTENDENT, an American, 30 to 45 years of age; good mechanic, good executive, systematic, progressive and aggressive; up on duplicate manufacturing with not less than three years' experience as superintendent of a gas engine factory; must have earned at least $1,800 per annum and saved something; to such a person we offer superintendency of our modern gas engine works, backed by all of the money, tools, appliances and material necessary to turn out 3,000 engines per year at least possible expense; time is an important consideration; give full and complete history and be prepared to pay us a visit, if apparently satisfactory. WITTE IRON WORKS CO., Kansas City, Mo.

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